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HON. JONATHAN AUSTIN,
Third President Hawaiian Sugar Planters' Association
1884.

In the eastern sugar market there has been no change in prices, yet there is every prospect of a trade war between the beet sugar interests and cane sugar. The Cuban crop has probably all been taken by the American refineries, and with the American and Hawaiian beet and cane crops added, the demand for European beet sugar must rapidly decrease. There has been no change in the wholesale price of sugar up to latest advices.

A great freeze occurred in Louisiana in December, which was very unfavorable to that portion of the cane crop left in the fields, and especially to the standing cane. The usual plan of protection for sugar cane has been to windrow the cane after the bud has been killed, and the freeze of November 18 was so slight that in many cases the bud was not killed, and much of such cane was left standing until the present time. This cane has met the brunt of the freezing weather, and will necessarily suffer very much where the harvest is prolonged many days.—La. Planter.

The Oceanic Steamship Company, of San Francisco, has entered into a contract with the local government for the construction of a wharf at Papeete. The government is to pay, upon completion of the wharf, the sum of $4,246. The Oceanic Steamship Company is to have the exclusive right to the wharf at all times, free of charge, for four years.

If the report regarding the release of Miss Stone by the Bulgarians is confirmed, it will afford her a grand opportunity to repay those who have advanced the ransom of $60,000, by preparing and publishing a book, detailing her adventures and sufferings while a captive. If such a narrative can be prepared, well gotten up and well illustrated, and sold at a moderate popular price, the book would find a sale of a million copies—sufficient to repay whatever has been raised for her release.

Referring to President Roosevelt's message to Congress, an exchange says: It was a fine literary production, captivating through its simplicity of statement, and hence there was force in every paragraph. No finer tribute to the late President McKinley has yet been penned. And then the message was so dominantly American. Every subject brought to the attention of Congress was so put as to make it appear essential to the welfare of the Nation. It was a fine paper and cannot fail to strengthen confidence in the President.

A large transaction has lately been consummated in connection with one of the largest and best equipped sugar properties in the Island of Cuba, through which this property passes into the hands of the Gramercy Sugar Refinery in Louisiana. This is the Constancia plantation, and there are some sixty-five thousand acres of land involved in the purchase, together with a magnificent sugar house, and it is anticipated that fully 200,000 tons of cane will be worked up by them this year.

Congress having adjourned until January 6th, the question of the duty on Cuban sugars remained in abeyance. The belief is, however, spreading that some reduction will be made; as to the amount of the reduction or when it will go into effect it is still impossible to say. Whatever reduction is made in the duties on Cuban sugars will be exclusively for the benefit of the Cuban planters, and will not be shared by the American refiners until the Cuban production reaches such proportions that sugars paying higher rates of duty will not be required in this market.—Exchange Paper.

Very strong efforts are being made on the part of the President and some of the leading senators in Washington to secure the admission of the Cuban sugar crop at a reduced nominal duty, giving it practically a free entry. These efforts will result probably in the adoption of a reciprocity treaty admitting Cuban raw sugar under a nominal duty, in consideration of free entry of American merchandise into that island. The fear is entertained that, under this treaty, free trade between the two nations will be practically established, and as a result Cuba will find an almost free outlet for her large sugar crop, which before the war amounted to two millions of tons, and which may easily be augmented to three or four million tons annually. The effect of such legislation would surely be to crush out all domestic beet sugar manufacture, and possibly all cane sugar manufacture in the United States proper. Very powerful influences are being brought by parties in the United States to secure this measure, but with what result remains to be seen.

The following are the officers and trustees of the Hawaiian Sugar Planters' Association for the current year:

President.......................... W. G. Irwin
Vice-President.................... H. A. Isenberg
Secretary and Treasurer.. .... W. O. Smith
Auditor....................... Geo. H. Robertson

Trustees—W. G. Irwin, H. G. Isenberg, W. O. Smith, G. H. Robertson, J. B. Atherton, H. P. Baldwin, F. A. Schaefer, F. M. Swanzy, B. F. Dillingham.

CRYSTALIZATION IN MOTION.

At Oahu Plantation.

(Continued from last Number, Dec., 1901.)

I will point out the advantages and why this pan was built this way.

The large diameter, 14 ft. 3 in., in comparison to its total height of 16 ft. 9 in., strikes one right away. It is of no use to build a pan high to give it a large capacity, the higher a liquid stands above the heating body which makes it boil, the more difficult it is for the steam bubbles to form and to rise through the liquid; that this is the case with low purity masse-cuites, is hardly necessary to say. For those who want to study on this subject I can refer them to "Der Dampf in der Zuckerfabrik," by Dr. Karl Stammer. It is no improvement to distribute the steam coils nearly even through a narrow high vacuum pan; as the higher situated coils will naturally deliver the heat easier than the lower ones, the upper part of the mass will boil whilst the lower one is consistent. The writer knows that if every coil is provided with in and outlet valves, the steam pressure can be regulated in every one of them; he knows further that if he can do this with four or five moves or touches of his hand, he can pay more attention to the proper boiling process than if he has to do the same manipulations on a good many valves distributed out of handy reach. The poor man's nerves would soon be overstrained if he wants to do justice to himself and to his work.

The heating body in the O. S. Co.'s big pan is divided into three sections, one in the conical and two in the cylindrical part of the pan. Every one of these sections is fed either with live or exhaust steam and regulated with one valve only. Each one of them has one outlet for the condensed water which is separated again in one steam trap for each section, which water runs off freely to the hot well. The coils are all made of copper and built in horizontal rows above each other; those of the two upper sections have 2 in. diameter and stand 6 inches apart, measured horizontally from center to center and 2½ inches measured in vertical direction, thus leaving a 4-inch space between the coils for the masse-cuite to move vertically; there is only ½-inch opening between these coils measured vertically. The conical section of the heating body is built in another shape, the masse-cuite circulating differently in this part of the pan. The coils have here 2½ inches diameter, stand 6 inches distance apart like the upper coils, but measure 3 13-16 from center to center in a vertical direction, leaving an opening between them of 1 5-16 inches, so as to allow the masse-cuite to move more freely towards the center when the strike comes down. For the same reason the outside coils stand 8-10 inches from the walls in the conical and 4½ inches in the cylindrical part of the pan. The coils are each from 23 to 30 feet long and have an inclination on that length of 1 3-16 inches, which allows the condensed water to run off freely; furthermore, they are well inter-connected and supported so that they cannot sag.

The outlet opening for the masse-cuite is 3 ft. 7 in. in diameter and the highest coil 9 ft. 6 in. from the bottom of the pan. Our 25 ton pan is constructed differently but on the same principle. The heating body is built as low as possible. The top coil measures 5 ft. 8 in. from the bottom of the pan, the cone is 4 ft. 2 in. high and the cylindrical part 11 ft. 2 in. by a diameter of 9 ft. 6 in. The heating surface is 750 sq. ft. in the small pan and 1,500 sq. ft. in the large one.

The masse-cuite drops on a chute which conveys it to the crystallizers.

A strike should never be made larger than one crystallizer can hold. Mixing of different masse-cuites should never be done, false grain is sure to form when the first part has been cooled considerably before the rest is mixed with it. The crystallizer should be heated beforehand to the same temperature as the masse-cuite which it is going to receive, to prevent any false grain forming when the masse-cuite comes in contact with the walls of the crystallizer.

The success we had in our mill was mainly due to the perfect construction of our vacuum pans. The bulk of the work has been done in them and only a small, but the most difficult, amount remained for the crystallizers to do.

The mixing of the first masse-cuite in the pan with molasses of a lower purity is done to keep the mass in a liquid form and to enable the sugar to crystallize out as much as possible in the first formed grain. If these molasses contain crystallizable sugar, a part of this will grow on the already existing crystals and can be obtained together with these. The masse-cuite when leaving the pan should be liquid enough to allow a regular stirring up by the mixing apparatus. After cooling down, the masse-cuite should centrifugal easily.

The quantities of molasses to be drawn into the pan depend mainly upon the viscosity of the mixed masse-cuite and have to be determined practically by every sugar manufacturer for himself. Our syrups are concentrated to about 61.0° Brix. The molasses to be mixed with the first masse-cuite are diluted to 65° Brix. and heated up to about 155° Fahr. A small amount of caustic soda is added to the molasses before diluting these, so as to have it properly mixed. The soda takes the place of the lime in different organic salts, making the lime free and relieving the viscosity of the molasses to a certain extent. So much molasses are drawn in the pan that the mixture has about 70% purity. This is a figure we kept up for a good length of time during last season. If the viscosity of the juices, which entirely depends on the quality of the cane, allows us to take more molasses in the pan and lower the purity more, we do so. For two months last season and only one month of this season, we brought the purity of our first molasses down as low as 42-44%; during the season in general, we brought it down to 52-54%. The work at the centrifugals, the quality of the sugar, settles the work at the vacuum pans. No rules can be laid down. Experience makes the master, as is the case with everything.

Experiments of Claassen with sugar containing solutions showed that the viscosity of supersaturated masse-cuites increased rapidly after cooling and that the conditions for the crystallization of the sugar became much more unfavorable on account of that viscosity. This showed that by boiling to a lesser concentration, he obtained more sugar of better quality under equal conditions of purity. The size of the grain has also a great influence upon the quantity of sugar obtained. Crystals of medium size give the best results. If they are boiled large, there is more space between them and the sugar molecules have opportunity to form new grain, which will run off with the molasses during centrifugaling.

When the number and capacity of the crystallizers is large enough, it is better to drop the strike at a higher temperature and less concentrated, because a more regular cooling takes place and a better crystal will be obtained; a part of the work of the vacuum pan is relieved by the crystallizers in this case. Still, the most part of the work is done in the vacuum pans. When the masse-cuite falls in the crystallizer, the molasses between the crystals have already such a low purity and are so tough that the sugar it still contains in solution will crystallize very slowly. It is crystallization in motion and a proper way of cooling, which can improve the rapid extraction of this sugar; the more viscous the molasses are, the slower the sugar will crystallize out. The larger the crystallizing plant is, the more time the masse-cuite has to cool down and the better results will be obtained. We cool our first masse-cuite only six hours because the crystallizing capacity we can use for this purpose is only 45% of the total. We expect to build a proper conveyor which will enable us to use all our crystallizers for making one grade of sugar. We will only be able to work this style when the juices have a low purity. We will have to bring the purity of the masse-cuite, when leaving the pan, down to 67%. If the mixture is higher than 67%, I do not expect the end molasses to reach 40%, which percentage we have taken as a limit.

Our boiling capacity does not allow us to take more than 45% of molasses in the pan when the mill operates at its full capacity, and as the molasses we take into the pan will have 43% purity, that of our syrup will not exceed 86.6%. If the purity is higher, we will have to adopt another method, which will be as follows:

Masse-cuite boiled from syrup only, having a purity of 86.6-95%, gives, when centrifugaled warm, molasses from 70-80%, which molasses can easily be granulated in the pan and treated as described above.

The first season we operated our crystallizers in this style and we were quite successful. The connection between the small vacuum pan and crystallizers consists of a 6-inch pipe, which is a good conveyor for molasses boiled to string-proof but not for regular masse-cuite. It often cost us a good deal of trouble to get the stiff masse-cuite into the crystallizers through this pipe. The sugar was of good grain and polarized 93°. This is the average polarization of our first product at present when not washed. We use a splendid washing apparatus which dissolves practically the smallest amount of sugar in the centrifugals. Comparative tests taken between the molasses separated in the laboratory from the masse-cuite before drying and the trickles running from the centrifugals showed an increase of averaging only 1½% in purity, never more than 2%. The decrease in purity of the molasses between the crystals in the first masse-cuite in the crystallizers was no more than 4 degrees in 6 hours but the sugar that crystallized out was grained well because it was in form of first product; if the masse-cuite had been dried right away this amount would have been lost in the molasses; if the masse-cuite had been cooled at rest, the sugar crystallizing out would have grained by itself, formed small crystals, and would have gone the same way. This is particularly the advantage of crystallization in motion, that, while cooling, the sugar that is bound to crystallize out grows on the already existing grains. Here are a few figures taken from the manual of Prinsen Geerligs on the manufacturing of cane sugar in Java.

Method of Cooling.	MASSECUITE.					MOLASSES.							
	Sucrose.	Glucose.	Ashes.	Moisture.	Purity.	Sucrose.	Glucose.	Ashes.	Moisture.	Purity.	Crystals present	Crystals Obtained.	Crystals lost on 100 Sucrose.
At rest	74.1	1107	1.54	9.02	81.4	32.9	28.59	3.91	23.37	42.86	61.62	51.51	16.40
At rest	78.9	8.99	1.16	7.76	85.32	33.7	28.12	3.65	24.50	44.63	68.22	58.81	13.79
At rest	79.0	8.47	1.15	7.82	85.72	32.9	27.52	3.72	26.12	44.67	69.09	55.28	19.88
In motion	77.0	9.62	2.51	7.49	83.45	35.3	26.54	6.70	22.94	46.40	64.00	64.00	0

In this synopsis, the figures for molasses do not concern the molasses obtained from the centrifugals but those present between the crystals in the cooled down masse-cuite. By comparing the analysis-figures of this molasses and of the masse-cuite, the figures are determined which represent the quantity of crystallized sugar, the figures for the amount of crystals obtained in the centrifugals are determined in the same way.

The quantities of sugar crystallized out are not very different, also the chemical analysis of masse-cuite and molasses did not show great differences, but the quantities of sugar lost through the centrifugal gauze show other figures. From the sugar crystallized out in motion, all the crystals were obtained, while in the other cases where the crystallization took place at rest, no less than 13-20% was lost in the centrifugals, because that sugar crystallized out by itself and formed such small grains that it went through the centrifugal lining together with the molasses. The point is to make the sugar crystallize out in an obtainable size. See last column in above table.

Our surplus first molasses with a purity of 45-52 was boiled at string-proof, run into one of the 12 crystallizers used for our seconds, and dried after cooling for 8-9 days. The purity went down to 35-42% and the sugar obtained polarized 85°. It amounted to 4.8% of the total quantity of sugar produced and was remelted.

The introduction of crystallization in motion also requires an increased capacity of the centrifugal station.

1st. A larger quantity of masse-cuite, proportionate to the amount of molasses drawn in the pan has to be dried.

2nd. The centrifugaling of these mixed boilings takes more time on account of the high degree of viscosity of the non-sugar composing parts of the masse-cuite.

Another important question is the keeping quality of the sugar obtained with this process.

This subject, "The decrease of polarization of sugar in transit," has been treated at last year's meeting of the Javan sugar planters and it is from the report of that meeting that I give the following lines:

Several chemists have made thorough experiments and come to different results. Every one of them stated that moisture was required and that the real cause of the decrease was—

A. The influence of the moisture itself. (Serrurier.)

B. An acid. (Winter.)

C. The influence of micro-organisms. (Maxwell, Shorey.)

That water alone should have such a fatal effect is not evident, because it has been proved that sterilized sugar solutions can be kept for years without deteriorating; when diluted solutions keep well, provided they do not contain micro-organisms, how much greater is not the chance for sugar that is a little moist to keep its quality.

Again, acidity alone does not need to be the sole cause.

Prinsen Geerligs observed that a lot of white, refined cane sugar from Hongkong, packed in mats and kept in a moist warehouse, lost about 5% in polarization within 4 months' time. The moisture was 2.25% and the amount of glucose, which originally must have been very small, was 2.35%; still, the sugar was of a neutral reaction. Neither acid, nor ashes components, nor derivates of glucose could have caused the inversion.

So as to find out experimentally if water alone, or with the aid of acids or micro-organisms, induced the rapid decrease in quality of sugar, Prinsen Geerligs and others made several tests; the descriptions of these are not at all in place here, I will simply repeat the conclusions they came to.

Prinsen Geerligs found that dry sugar remains good in storage even if it contains germs, but that sugar not sterilized inverts very soon when moist and does not become acid in the beginning of the inversion. Sugar in which the microbes are killed as much as technically possible decreases too in quality but much less than sugar which contains more germs. Alcalinity of the wet sugar is not at all a sufficient preventative against inversion. As long as the re-action is strong, alcaline (0.2% soda) inversion proceeds slowly, but if the alcalinity is neutralized, be it by acids which are separated either by moulds or originated from glucose, then there is no more difference (apparently) between the alcaline and the neutral sugar.

Although the test is not decisive because the sugar could not be obtained perfectly free of germs, the result shows that inversion in storage is caused by microbes, made possible by the presence of moisture. Mr. Sax remarked that sugar lost decidedly in keeping quality since crystallization in motion was introduced in sugar manufacturing.

Dried muscovado of 97° polarization obtained from molasses with low purity (35%) lost in transit 2 degrees and more. This rapid loss can not be caused by microbes for the following reason:

Sugar when leaving the dryer (Hersey or Cook's apparatus) is practically sterile as Mr. Prinsen Geerligs stated. When a similarly dried sugar, obtained from a very poor molasses polarizes about 97°, that sugar will surely not contain in a dry state any more water than another one made of a high purity molasses because the ashes and non-sugar components of the first one are more. For the development of microbes, the necessary moisture lacks in such dry sugars, besides the attraction of moisture is excluded during the packing. Mr. Sax concludes that in similar cases where a rapid decrease takes place in the beginning other agentia than microbes must be present and he believes these to be the salts and organic non-sugars which the sugar will contain in larger quantities when treated with poor molasses.

Not only the larger quantities of salts but also the quality of them can be of influence and because they are present in a concentrated form, they can cause inversion. When the crystals are small, which will evidently be the case when juices are bad and the molasses poor, the sugar will be easier affected by the causes which do destroy it. Microbes were present in sugar just as well in former years as is now the case. The conclusions of these gentlemen were the most valuable in my opinion and I think that if the sugar is made sterile and washed in the centrifugals as well and advantageously as practically possible, it will stand the journey to San Francisco or New York better.

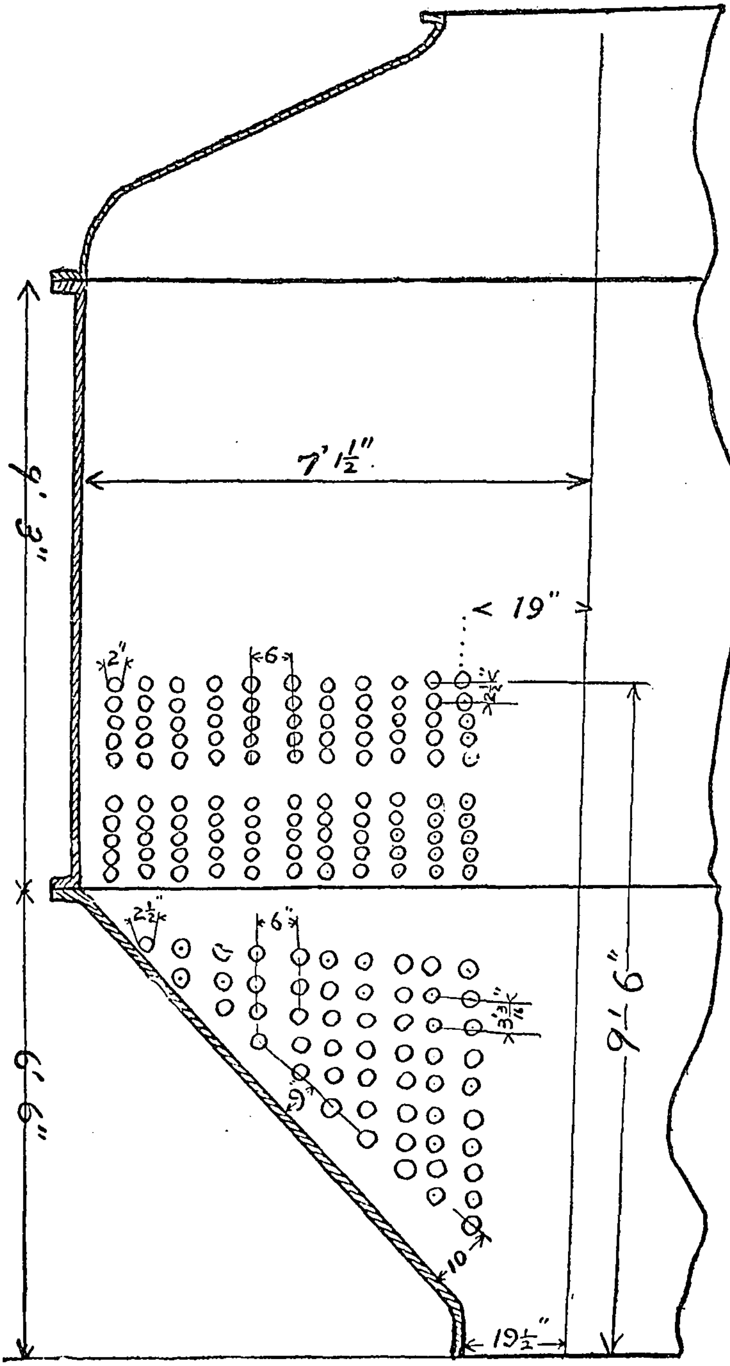
As it is easily comprehended that a sugar mill with crystallization in motion, necessitates larger and improved boiling capacity over a modus operandi of the present general way of sugar making, my personal experience here as well as in Europe, proves that crystallization in motion is as far superior to the last, as this is to the ancient open kettle way. We reduce inversion during the manufacturing process, save labor and change our raw products in a shorter time into cash, i. e., save time and "time is money."

P. A. G. Messchaert,
Chemist, Oahu Sugar Co.

:o:

A team of mules walking at the rate of two miles per hour in sandy land will cultivate with a disc cultivator 16 acres in a day of 11 hours. In eight days they have gotten over 128 acres. To complete the cultivation of 128 acres in the same time according to subdivision (a), four teams in all are required, thus making an average of 32 acres to the team. This would be the case the whole season through if we continued working the corn crop, but by dispensing with this crop one-third of the acreage ise set aside; by this means the acreage is reduced to a fraction over 21 acres per team.

The Division of Entomology of Washington has of late given a short notice relating to an insect attacking sugar-beet leaves found in New Mexico. Its presence was not noticed until the year 1897. " Afew of the beetles locally known as the 'French bug' were found on the date given by digging in the earth by the side of a beet to the depth of about six inches. Neither eggs nor larvae were to be found at this time * * * the beetles lay their eggs on the underside of a leaf, that they hatch in about six days, and that the young larvae commence feeding at once and continue for nine or ten days, when they dig their way into the ground, and, a few days later come forth as beetles. It appears that the beetle in question is what is known as maritime species occurring near the sea shore and in saline localities. It is known from Massachusetts to Florida.—Sugar Beet.



OIL ARRANGEMENT IN 50 TON VACUUM PAN AT OAHU MILL.

REPORT ON MANUFACTURE.

Gentlemen:—Your committee on sugar manufacture submits the following report.

In modern factories nine-roller mills provided with Krajewsky crushers or other equally efficient apparatus for preparing the cane, are now being adopted.

It is well known that different varieties of cane vary in milling qualities, some parting with their juices more readily than others and there is often a great difference in the fiber and sugar content from fields—especially if the land is rolling—where the same variety of cane is grown.

It is usually considered that with mills as described, a good extraction approximates 93% of the total sugar in the cane. For the purpose of comparing the influence of the fiber and sucrose content of the cane on the extraction, and assuming that the analysis of the bagasse, in all cases, is as follows,—Sucrose 5%, fiber 46%, the following table has been prepared:

Sucrose in Cane.		Fiber in Cane.			
		10%	11%	12%	13%
16%	Extraction=	93.25	92.56	91.87	91.18
15%	Extraction=	92.80	92.06	91.33	90.60
14%	Extraction=	92.28	91.50	90.70	89.78
13%	Extraction=	91.69	90.84	90.00	89.15

The difference of the increased fiber content in the cane, will be found in actual practice to have a greater effect in preventing the extraction of the juice than that given in the above table.

*In Louisiana the difference between 10% and 12% of fiber in the cane, reduces its value 6% from an extraction point of view.

It will be apparent, that a mill grinding cane containing 13% sugar and 13% fiber, and obtaining an extraction of 89.15% will be doing better work than a mill grinding cane of 16% sugar and 10% fiber and obtaining an extraction of 93.25%.

Maceration.—The advantages of maceration in the extraction of sugar from the cane are now recognized in all sugar cane countries, but this system is not yet used to such an extent in these Islands, as at the Colonial Sugar Refinery Company's estates in Fiji and Queensland.

In all cases where the juice approximates a purity of 90% a dilution of from 10 to 15% may be used to advantage, and if the sucrose content of the cane is high, a dilution of from 20 to 25% will be found profitable, provided the bagasse furnishes sufficient fuel for the requirements of the factory. If water not exceeding a temperature of 165 F. be used, the greater part of the impurities extracted by the maceration water will be removed in clarifying.

*La. Planter, Nov. 24, 1900.

DIFFUSION.—The diffusion process is not popular as a means of extracting sugar from cane, on account of the cost of fuel, and also because the long exposure of the cane to water of high temperature, * extracts more, than by the milling process, of the pectinous (Gums) and nitrogenous substances (Amids) which cannot be removed by the ordinary processes of clarification and consequently interfere with the recovery of the sugar; this is more noticable in canes having juices of low purity.

CLARIFICATION.—The Deming system is now most in favor with planters making sugar for refineries. Mr. Prinsen Geerligs of Java says of superheating, "From a chemical point of view superheat clarification stands in no respects behind the usual defecation process, whilst its mechanical advantages are many."

EVAPORATION.—The concentration of the clarified and settled or filtered juice should be performed as rapidly as possible, and this is now accomplished in modern factories by means of the Lillie evaporators.

FILTRATION.—As much of the impurities are precipitated in concentrating the juice, filtering the syrup, particularly if the juice has been superheated would be of advantage as it would remove many of these impurities.

CRYSTALLIZATION.—In order to get the best results from impure juices in boiling to grain, the vacuum pan should have ample heating surface, well distributed, so that "the circulation is systematized and defined into unconflicting currents, from the peripheral extremities towards the center, whereby the essential momentum of circulation can be established. Crystallizers are now in use in several factories in these Islands.

A report of the investigations of Mr. Princen Geerligs in Java on crystallizer work has already been brought to your attention by Mr. Geo. Ross in the September number of the Planters' Monthly.

Water-driven centrifugals are growing in favor and have many advantages over the belt driven machines. Granulators are used only in a few factories.

Cleanliness in all departments, careful clarification of the juice and watchfulness to prevent incipient fermentation in the sugar house, this and careful drying of the sugar before packing will usually be found sufficient to prevent deterioration. It has been suggested to disinfect the packing material and to protect the sugar as much as possible from moisture by suitable covering, when stored or in transit. It has been found that the alkalinity of sugar does not affect its keeping qualities.

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*Result of experiments of Dr. Maxwell and J. T. Crawley.

The value of press cake as a fertilizer has already been brought to your attention in the report on Manufacture of 1899.

Excellent results have been obtained by burning the bagasse in furnaces of the Dutch oven type having step ladder grate bars. The value of bagasse as it comes from the mills as compared with good coal is as follows:

3.34 tons of bagasse, containing 42.50% moisture=one ton of coal.

4.17 tons of bagasse, containing 51.00% moisture=one ton of coal.

Mr. Hubert Edson of Louisiana proposes to use the heat of the chimney gases to dry the bagasse before using and in this way effect a saving of 15% in its fuel value.*

The process of making paper from bagasse at a large mill in Texas is described in the Louisiana Planter of October 5th, "8,000,000 lbs. of paper were made from 40,000,000 lbs. of bagasse. The paper sells at 2c per lb. making the value of this product $160,000.00. The cost of manufacture is not given, but that it pays is shown by the fact that mills in Louisiana will shortly add this branch of manufacture to their establishments. The day may be not far distant when sugar will be shipped in containers made from bagasse, and having greater strength than those now used, and with air and waterproof qualities.

Molasses as Food for Live Stock.—The value of sugar as a food has been well demonstrated by numerous experiments made in Europe and America. The value of molasses as a food for live stock should not be overlooked. In Germany molasses is prepared as food for cattle by heating it up to 90° and then introducing it in a steady stream into a mechanical mixer, at the same time the forage with which the molasses is to be incorporated is also fed into the machine. There issues from the mixer a coarse-grained mass which in several hours becomes a dry product easily broken up and preserved. Materials used are wheat straw, corn, etc.

A food for stock has been made by grinding cornstalks to powder, mixing this with molasses and then pressing it into cakes by means of a hydraulic press. It can then be shipped as easily as baled hay. For feeding it is broken up and mixed with water. Extensive experiments in feeding molasses to horses have been made by the Colonial Sugar Refining Company and the ration recommended for animals weighing 1200 lbs. is 15 lbs. molasses, 3 lbs. bran and 4 lbs. maize, per day, with all the cane tops they will eat. This system of feeding is endorsed by Dr. Dalrymple, the most prominent Veterinarian in Louisiana.

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*La. Planter April 14th, 1900.

MANUFACTURE OF ALCOHOL FROM MOLASSES.—The process of working cane sugar molasses is essentially the same as for beet sugar molasses. The molasses is diluted with water and acidulated with sulphuric acid until it will slightly redden litmus paper. The process in a large distillery in France is as follows:* 8,140 lbs. of molasses are taken for each fermenting vat of 41,884 gallons capacity, which gives to the mash a concentration of about 14 per cent. To this is added sufficient molasses lees, which increases the concentration about 5 per cent. The mass is brought to fermentation with beer yeast at a temperature 68° to 77° F. Fermentation is extremely violent, and produces in the extraordinarily large quantity of mash fermenting in one vat, such an increase in temperature as to necessitate the cooling of the fermenting mass by cold water circulating in large serpentine pipes placed in the center of the vat. The temperature must never rise above 93.2 F. Should the commencement of fermentation be delayed, the temperature can be raised by the circulation of warm water through the serpentine pipes. Fermentation is generally considered complete in 48 hours, and the yield is given as 13.6 gallons of 97 per cent alcohol from 100 kilograms (220) lbs.) of molasses.

The manufacture of molasses into alcohol could be accomplished in the sugar house without additional machinery. Syrup and molasses tanks could be used for fermenting vats and an ordinary standard double effect can easily be converted into a still by keeping the tubes or drum of the second effect surrounded by cold water and drawing off the vapor from the mash in the first pan, as condensed, through the exhaust pipe of the second effect. Two parts of kiln dried malt and one part of compressed yeast (beer yeast of good quality) to 100 of molasses should be used to start fermentation.

Very respectfully,

E. E. OLDING, Chairman,
C. C. KENNEDY, Member,
AUG. AHRENS, Member,
W. GOODALE, Member,
GEO. FAIRCHILD, Member.

"A man's own good breeding," says Chesterfield, "is the best security against other people's ill manners. It carries along with it a dignity that is respected by the most petulant. Ill breeding invites and authorizes the familiarity of the most timid. No man ever said a pert thing to the Duke of Marlborough, or a civil one to Sir Robert Walpole."

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* Practical Treatise on the raw materials and the distillation and rectification of alcohol, by William T. Brannt.

CRYSTALIZATION IN MOTION AT KEALIA, KAUAI.

October 16th, 1901.

E. E. OLDING, ESQ., Kohala, Hawaii.

DEAR SIR:—We erected a new mill last year but were able to grind but a portion of the crop with it, and owing to irregular work, caused by the labor conditions our data, while quite complete, is not extensive enough to be of interest owing to the short time we had at our disposal. So many new experiments require at least a season to enable one to speak of the benefits or demerits of any system. We did find that our sand filters were as efficacious on mill juices as they were upon the diffusion juices, and we also found that we had more need for them owing to the large amount of suspended fibre in the mill juices which is not present in the diffusion juice.

We have found that there are more ways than one to work crystallization in motion, and that the work of preparing the molasses for the crystalizers is different from the old process. We are not prepared to say which of the many trials we have made is going to prove the proper one, and we believe that each place will have to work out its own solution, which fact is true of nearly all plantation work. What may prove of benefit to the Java planters with their low juices may not be applicable here where our juices are much purer. We have had excellent work with the Kilby pans. Those who have not had the same experience may find their trouble in low juices from virgin soils. We have been obliged to boil for 12 hours in our old pans on juice that came from swampy land. The old pans had 4-inch coils, and with all the steam we could put on, the strike could not be made to finish in less time. We do not aim to boil a strike too quickly and think that more time given to the boiling results in better and more economical work. With what little experience we have had we are inclined to be skeptical in regard to the high extraction that has been reported from nine roller mills, especially when such extraction has been gained without the use of high maceration.

We find that we can grind without using extra fuel, but when we did so we were burning sugar instead of coal, and therefore it pays to use supplemental fuel and get a better extraction. We do not require the same proportion of extra fuel as we did with diffusion. Last year was hardly a fair criterion, however, owing to the unstable labor conditions. A diffusion plant must be worked with steady regularity, running it beyond or less than its capacity results in immediate loss, and we find the same is true of the nine roller mill, although we often have been told that a mill was not subject to loss under such conditions. It may be true that the loss is not as great as with the diffusion, still we find that an even, regular feed is as much to be desired as the even feed to the cutters, or more particularly the batteries of a diffusion plant.

Our juices are very regular and good and thus diffusion always has worked to our satisfaction, until the plantation outgrew the capacity of the diffusion plant and we were compelled to push it beyond its working capacity, and then we did not get the extraction we could have obtained where the plant is worked only up to its capacity. Where low juices abound, we can imagine diffusion would not be popular, for we always had trouble when we were on a 150 acre field of swamp land.

We also find that a nine roller mill plant requires the same chemical control that a diffusion plant does, and that the extraction is subject to the condition of the cane, whether it is hard or soft.

The one main objection to the diffusion plant is in the machines that are in use to prepare the chips for the battery. If the cane comes from land that is rolling the setting of the knives cannot meet all the different conditions of cane, in the gulches the cane is soft and on the side hills very hard; each of these canes requires a different setting of the knives which is not possible in regular work and thus you get an irregular chip which prevents good work in the battery. This matter is more easily controlled in the nine-roller mill, still the extraction varies with the class of cane, possibly the presence of a crusher might regulate this matter.

The labor trouble has been so acute with us that I presume you will excuse me on that ground alone, but I really do not feel that I have any data at this time to give out. Trusting that the fellow members on your committee will be able to give you full reports, I am, Yours very truly,

GEO. H. FAIRCHILD.

REPORT ON CRYSTALLIZER WORK.

The following gives the average results of a month's work with the crystallizers, making three grades of sugar, 1st grade, by boiling straight syrup; 2nd, boiling half syrup and No. 1 molasses; third grade, boiling half syrup and half No. 2 molasses:

FIRST GRADE

TREATED			OBTAINED			SUGAR		MOLASSES					
SYRUP			MASSECUITE								TEM ENTER	TEM DRIED	TIME IN
Brix	Suc	Purity	Brix	Suc	Purity	LBS	POL	Brix	Suc	Purity	Cryst		Cryst
43.4	35.7	82.2	91.6	75.8	82.3	47,600	96.0°	83.5	50.7	60.7	60°	39°	20 hours

SECOND GRADE.

TREATED			OBTAINED			SUGAR		MOLASSES					
SYRUP			MASSECUITE								TEM ENTER	TEM DRIED	TIME IN
Brix	Suc	Purity	Brix	Suc	Purity	LBS	POL	Brix	Suc	Purity	Cryst		Cryst
½ Syrup— 43.4 ½ No 1 Mol— 83 5	 35.7 50.7	 82.2 60.7	92.1	69.2	75.1	36,400	93.3	86.6	42.5	49.1	57°	34°	30 hours

THIRD GRADE.

TREATED			OBTAINED			SUGAR		MOLASSES					
SYRUP			MASSECUITE								TEM ENTER	TEM DRIED	TIME IN
Brix	Suc	Purity	Brix	Suc	Purity	LBS	POL	Brix	Suc	Purity	Cryst		Cryst
½ Syrup— 43.4 ½ No 2 Mol— 86 6	 35.7 42.5	 82 2 49.1	93.5	63.4	67.8	34,600	92 9	88 9	38.4	43.2	57°	31°	61 hours

Produced 1,916 tons of sugar of 94.1% Pol'n. 75,690 gallons of molasses of which 40,420 gallons was thrown away direct from the crystallizers at Brix 89.5, Sucrose 36.6, Purity 40.9 and the remaining put in tanks at Brix 88.9, Sucrose 38.4, Purity 43.2. Three months later this was dried, yielding 2½ lbs. 78% Pol'n sugar a gallon and giving a final molasses of Brix 90.2, Sucrose 34.5, Purity 38.2.

Comparing results in which the masse-cuites have the same purity and remained in the crystallizers the same length of time, the effect of the density of the masse-cuite upon the molasses, is shown:

NUMBER 1.

MASSECUITE			YIELDING MOLASSES			TIME IN CRYST
Brix	Suc	Purity	Brix	Suc	Purity	
91.4	75.4	88.60	82.4	51.4	62.4	12 hours
94.3	77.0	81.65	85.6	48.6	56.77	12 "
89.7	75.2	83.8	80.8	57.6	71.3	5 "
90.8	76 0	83.7	82.7	56.2	68.0	4 "

NUMBER 2.

MASSECUITE			YIELDING MOLASSES			TIME IN CRYST
Brix	Suc	Purity	Brix	Suc	Purity	
92.4	65.2	70.6	85.1	40.4	47 5	6 hours
93.5	65.5	70.1	86.7	39.0	45.0	5 "
91.9	65.5	70.1	86.2	45.6	52.9	12 "
93.8	66.5	70.9	88.0	42.2	49.0	12 "

NUMBER 3.

MASSECUITE			YIELDING MOLASSES			TIME IN CRYST
Brix	Suc	Purity	Brix	Suc	Purity	
92.7	60 0	64.7	87.7	38.3	43.6	46 hours
94.4	61.0	64.6	89.7	36 4	40.6	42 "
93 2	62 8	67 4	88.6	41.5	48.5	35 "
96.3	65.0	67.5	86.7	37.2	42.9	30 "

The following shows the result of the time a masse-cuite remains in a crystallizer, also the effect of reducing the temperature:

NUMBER 1.

MASSECUITE			YIELDING MOLASSES				
Brix	Suc	Purity	Brix	Suc	Molasses	TEM REDUCED FROM—TO	TIME IN CRYSTALLIZER
90.8	76.0	83 7	82.7	56.2	68.0	61°—53°	4 hours
92.4	77.0	83 3	84.0	53.2	63.3	58°—38°	15 "
93.5	76.6	79.8	86.7	50.6	58 4	60°—45°	18 "
93.5	75.4	80 6	86 1	43.2	50.2	65°—42°	42 "

NUMBER 2.

MASSECUITE			YIELDING MOLASSES				
Brix	Suc	Purity	Brix	Suc	Molasses	TEM REDUCED FROM—TO	TIME IN CRYSTALLIZER
92.1	67.0	72.7	78.1	45.8	58.6	55°—38°	11 hours
93.8	68 2	72.7	85.9	42 6	49.6	57° - 41°	20 "
90 8	67.8	74.7	85.6	48.6	56 8	56°—42°	8 "
93 2	68 0	73.0	86.9	41.4	47.6	56°—30°	60 "

NUMBER 3.

MASSECUITE			YIELDING MOLASSES				
Brix	Suc	Purity	Brix	Suc	Molasses	TEM REDUCED FROM—TO	TIME IN CRYSTALLIZER
94 1	61.4	65.3	91 6	35 4	38.7	60°—32°	69 hours
94 1	62.4	66.3	88-9	40 0	45.0	55°— 0°	20 "
94.4	59 8	63 3	90 5	34.6	38.0	60° - 20°	103 "
94.4	62.0	67 7	91.4	39 3	43.1	65°—29°	40 "

The above results are to be compared in couples. In each case the two masse-cuites have nearly the same purity and degree Brix but in the length of time they remained in the crystallizers, thus also causing a difference in the temperature. The effect of this on the molasses is evident. In these results there was no loss by inversion.

The best single result obtained by three boilings:

HEATING SYRUP	OBTAINING SUGAR	MOLASSES
Brix............37.8 Suc. ....31.7 Purity..........83.8	Pounds.......118,000 Polorization .93.75°	Brix .... . . 91 6 Suc ....35.4 Purity 38.7

Starting with a syrup of Brix 49.0, Sucrose 44.2, Purity 91.6, the best obtained by three boilings was molasses of Brix 86.68, Sucrose 44.0, purity 50.76; a fourth boiling of this boiling resulted in Brix 90.2, Sucrose 38.8, Purity 43.00 and a sugar Pol'n. 92.0%.

REPORT OF THE COMMITTEE ON DISEASES OF CANE.

THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

GENTLEMEN:—In our former reports we have spoken chiefly of the cane-borer, Sphenophorus Obscurus, as the most and only serious pest on these islands to the sugar cane.

Reports from Kauai, where the borer in former years had been most numerous, are very favorable. At Lihue, at least, where the war against the same had been carried on for several years past, the decease has been most noticed. Long ratoon is raised with success and is not seriously affected by the beetles. A fertilizer with a tendency of hardening the cane is also highly spoken of.

The statement of Mr. Weber that a single man is able to gather from 3,000 to 5,000 beetles daily in heaps of refuse of cane is very significant, for it means the destruction of about 300,000 to 700,000 eggs of the borer. We must try and get a substitute for the fermenting sugar-cane, which would likely answer the same purpose.

As far as my own experiences are concerned, lights are useless to attract the Sphenophorus, yet I am quite confident that an alluring substitute to cane could be used in trays to attract and destroy the same. I shall work out this problem thoroughly in the near future and report upon the results.

Mr. W. A. Baldwin speaks of the Sereh disease of Java. It is now universally admitted that this is not a disease but degeneration of the cane, chiefly of the Cheribon variety so largely planted in Java, and to my knowledge not yet present on our islands. If introduced here, in some localities at least, the same symptoms would doubtless develop upon this, as had been the case with the Malabar variety from Fiji that had shown such degeneration with us. And yet the rows of other cane adjoining this have never shown the slightest indication of any abnormal condition.

The Gum disease of Australia spoken of by the same gentleman, I have seen most prevalent in New South Wales, a district where the cane had suffered from the effects of frost.

I fully agree with Mr. Baldwin in the urgent necessity of burning the trash as soon as possible, after the cane is removed from the field, as we would thereby avoid any danger of breeding diseases. Exceptions, however, could be made in localities where the borer is not present, nor any other disease apparent. Here in my opinion, the burning with every second or third crop should be sufficient.

One new insect preying upon cane leaves is spoken of in the present report. So far, it is only seen at the Experimental

Station and but upon two varieties of cane, this we shall keep under careful observation. Should its effects upon cane become in any way serious, which in my opinion is not likely, it could be stamped out before spreading to any of the plantations. It can readily be prevented in being carried to other islands upon seedling cane by carefully removing and burning all the leaves upon which the insect breeds. The cane sticks could then be wrapped in bags, immersed in lime water, carbolic solution, or even pure water for a couple of hours, to destroy the young insects likely to be present.

It is more than likely, and Mr. Perkins is of the same opinion, that this insect has been present upon the islands for a long time, living upon various grasses.

LEAF-HOPPER (FULGORIDAE).

According to Mr. Clark, a small Homopterous insect appeared upon the sugar cane at the Experimental Station some twelve months since, affecting the Demerara and Rose Bamboo plants. Its presence is easily seen by the black and dirty appearance of the leaves, and more or less, red midribs.

The insect lives in company with its larva in large numbers behind leaf-sheaths, which it punctures to imbibe the sap of the plant. When mature it is exceedingly active in its habits, springing with suddenness from its resting place at the least disturbance. The eggs are oviposited into the midrib over a large extent, most numerous near the base, in groups of about from four to seven, and large quantities are often present in a single leaf. The surroundings of the sting become red, and in advanced stages the whole of the midrib becomes, more or less, of this color and brownish red.

With folded wings the insect measures from 5-6 m.m, and from 10-11 m.m. with wings expanded. It is yellowish brown with a dark fuscous mark in center of forewing two-fifths of its length. In the female, which is usually the larger, the spot is heavier marked.

We have quite a number of closely related species of this insect on the island, living upon various grasses and plants, both in the low lands and mountains. If the present species had been here long, or if newly introduced, I am, as yet, not able to decide. A similar insect, but somewhat smaller, is common upon corn and sorghum. This is likely the same as recorded in Australia upon those plants, and known under the name of Delphax Sp.

Krueger records Dicranothropis Vastatrix as common upon sugar cane in Java and Borneo. Delphax Sacchapivora from the West Indies. Eumetopina Kruegeri of the same habits as Dicranothopis Vastatrix, yet not so numerous, from Java and Borneo, and Phenice Maculosa, also common upon sugar cane and grasses, in Java. All these are related to the above insect.

I found Leis Conformis, a common Australian Lady-bird, and usually feeding on Aphids, preying upon larvae of a similar Homopterous insects in the north of Queensland.

Should this insect become numerous on any plantation, they could be kept in check by careful and repeated stripping and burning, immediately after, of the leaves containing the eggs. I do not anticipate any serious results from the above insect, which may have been present upon the island for many years. The thorough burning of the trash immediately after the harvest of the cane is the best remedy for this as well as other insect and fungus pests.

THE WEST INDIAN CANE BORER.

An insect known as the Lady-bird borer, Sphenophorus Sacchari, has been the subject of writing by C. A. Barber and others. This insect was wrongly named. It is really Sphenophorus sericens, occurring in Jamaica as well as Barbadoes, St. Kitts, Antigua, St. Lucia, British Guiana, and probably also in Trinidad. The grub feeds in cane, destroying everything but the rind. It then makes a fibrous cocoon and immerges as a brown and black weevil. It is not as yet certain whether this insect can be classed as a direct parasite or not. I have found it in the stumps of ratoon canes, in canes that have been planted, and in broken canes in fields, and it is probable that this insect cannot penetrate a sound growing cane, but enters at cut or broken surfaces. Should this be the case, little damage is likely to result from its attacks, but it is at present abundant and should be checked. This can be done by destroying all infested canes and by catching the mature insect in trays of molasses. Large numbers can be caught in this way if a tray of molasses is used with a light.—(H. Maxwell Lefroy, in West Indian Bulletin, Vol. 2, p. 41.)

A CONSIGNMENT OF CANE FROM THE ABOVE COUNTRY.

Some time during the spring of the present year, Mr. R. E. Blouin had written to Demerara for a select lot of seedling canes, to be cultivated on these islands.

As shown in note received by Mr. Eckart, the Diamond Plantation shipped the same on July 5th, 1901. As we have been able to trace it, the consignment came by way of New Orleans and had been shipped in San Francisco by the S. F. & S. J. R. R. Co. It arrived at this port on the S. S. Mariposa September 28. On October 12th, the Experimental Station was notified of the arrival of the same. Being late on Saturday it could not be brought out until Monday, October 14th. As agreed with Mr. Clark I examined the cane the following day.

The consignment consisted of a single sugar barrel with some eight holes surrounding the same, about one by five inches. The cane within having been tied up in bundles, according to the varieties, and were surrounded with dry leaves, both of the ends were tarred. We could find but very few sticks that had any moisture left, evidently the same had been dead for several weeks. Many of them and even the tarred ends showed holes from where some insects had issued. Every stick was split open and carefully examined, and was found to be inhabited by hundreds of our common ant, Pheidole Megacephala; a cosmopolitan species. Most of them showed the work of the cane borer, similar in all respects to the work of our own beetle, some even consisted but of a shell filled with loose fibre and many cocoons, open at the one end. We also found a few fresh traces of larvae of various stages, yet none of these could be detected, owing to the numerous ants that had devoured the same. Within one of the cocoons a pupa of the beetle was found partly devoured by the ants. At the bottom of the barrel a beetle was found which had been destroyed sometime previous by a fungoid disease. I found but two perfect cocoons, one containing a comparatively fresh insect, yet destroyed, by this parasitic fungus some two or three weeks previous. The second contained a living beetle. which was the only one in the whole consignment. The barrel and its contents were immediately burned.

In less than twenty-four hours, with the ready willingness of Mr. Boyd and his assistant, Mr. Campbell, of the Public Works department, I had the promise that within ten days the long wanted fumigation house would be erected at the Quarantine wharf. With this at hand we should be able, at least. to avoid the danger of introducing new pests into the port of Honolulu.

WHAT IS THIS LAST BORER?

For the present we must leave this question unanswered. I have no literature or specimens for comparison on hand to say with any certainty what the insect could be. From all appearances it cannot be the West Indian Sphenophorus Sericeus that may even prove identical with our Sphenophorus Obscurus, as a writer in the Bulletin of the Botanical Department, Jamaica, 1892, suggests. Calandra Palmarum is another borer destructive to sugar cane in Queensland, Louisiana and the West Indies. I have never seen this insect but know of the presence of a species in palms at Honolulu for the last eight years.

Of this much we are sure, the insect that came in the cane from Demerara is a very destructive pest to those plants, and all possible care must be exercised to prevent the same from taking a foot-hold here. All palms, banana plants and sugar cane in and around Honolulu will have to be carefully watched for the next twelve months at least, in case one or more of the beetles should have escaped while the plants lay at the wharf.

THE LIFE HISTORY OF CANE BORERS OF THE GENUS SPHENOPHORUS AND CALANDRA.

With the exception of our own species that we have studied, we have not a single data relating to the life history of any of these borers on sugar cane, and doubt that any had ever been worked out. Comparing it with our own species we will not be far off in saying this—the duration of the newly received borer from eggs to the mature insect requires about three months. This is the time consumed for the plants to reach Honolulu, where on examining practically all the cocoons were found empty. It would seem that before packing the seedling cane, this must have been exposed to the attacks of the borer, and the eggs and young larvae must have been present within when the ends were tarred and packed for shipment. While we do not accuse any one directly in gross carelessness of this sending, yet the senders lay themselves open to blame. With sugar cane above all things the greatest care should be exercised to avoid any possibility of introducing new pests.

NOTES ON THE RECENTLY INTRODUCED GRASS—PANICUM SPECTABILE, Nees.

It is hardly worth while to mention that every planter is acquainted with the Hilo grass, Paspalum Conjugatuum, and its value as a food for cattle. This grass has possession of our best grazing land to the exclusion of everything else. It even will cover the ground in partly opened forest land and here become a detriment not only to all the undergrowth but to the remaining trees as well, especially the soft wooded species as the handsome Kukui and even the Koa.

It is this grass that has been introduced into the Fiji Islands by the late Governor Thurston, which name it bears in that country. On those islands, as with us, it has proven anything but desirable. The celebrated Government Botanist for Victoria, Baron F. V. Mueller, who has done so much for the world at large, introduced the Panicum Spectabile, that, on my visit to the Rewa River, in 1899, had over-run the Hilo grass entirely and produced an abundance of the most nutritious food. The Baron in his Select Extra Tropical Plants, has this to say concerning the grass: "Panicum Spectabile," Nees. The "Caopin" of Angola, from West Africa transferred to many other tropical countries. A rather succulent, very fattening grass, famed not only in its native land, but also long since in Brazil. This grass which was with the help of the great Kew establishment first obtained by the author for Australia and Polynesia, is according to Mr. R. L. Holmes "the wonder of all beholders in Fiji, strangling by its running roots almost everything in its course; at its original starting point forming a mass of the richest green foliage, over six feet high, gradually lowering to the outer border, where a network of shoots or runners covers the ground. It roots at the joints and sends up a mass of the softest and most luscious fodder." In Fiji it runs over the soil at ther rate of ten feet in three months. Readily propagated by pieces of the procumbent stem which roots freely at each joint. Also spoken of in high praise on account of its astonishing growth by Mr. Edgar, of Rockhamden Botanic Gardens, Queensland. Requires to be well fed down. It may be assumed that at present 300 well defined species of Panicum are known, chiefly tropical and sub-tropical, which are the richest in species amongst grasses.

This grass has been grown by Mr. Haughs in the Government Nursery from seeds found but very rarely on the Rewa River, Fiji, Nov. 1899 by myself. On my return to the islands in April 1900, the young plants were still in the original box, and a month later I planted some out in hopes of obtaining seeds, but so far have not met with any success. At the same time young plants were given to the American Colony at Wahiawa, others were sent up to Nuuanu, and it is from this place that the grass is now distributed by the present Commissioner of Agriculture.

A few weeks since a warning article appeared in the newspaper regarding the "Para grass," by which name this Panicum has been wrongly termed; the writer therein warns the sugar planters of its dangerous habits in over-running the plantations as has been the case in the West Indies. Baron V. Mueller mentions two species of Panicum known under the name of "Para grass." P. Barbinode, Brazil. Valuable as a fodder-grass. Passes also as Para grass, and P. Molle. Warmer parts of America, Africa and Asia, one of the Para grasses. A perennial, very flattering pasture grass, of luxuriant growth attaining a height of six feet."

Semler, Tropische Agricultur, Vol. 4, p. 453, has probably the right grass in speaking of the Para grass—Panicum Molle, he says: It resembles the Guinea grass, and its origin also is Africa, yet the leaves are smaller and shorter, and the spikes are not so large, nor their branches so long. From Africa this grass has been introduced into Brazil where it is largely planted, from there it was brought to Venezuela, from where, but especially from Para, it had been received by the West Indies. For this reason it is there known as the Para grass and is now best known under this name. In the Southern West Indies, but chiefly in Trinidad, it is largely planted, yet here it is a great pest to the sugar planter, who cannot get rid of the same. Its high quality as a feed for cattle is generally acknowledged and whoever has seen the animals at grazing, how first they select and eat the Para grass before going over to the others, will no longer be in doubt.

Paspalum Conjugatum first appeared about 1840 in the district of Hilo and soon spread there to such an extent as to crowd out nearly every other kind of grass, thereby injuring greatly the pasturage; for not even donkeys and mules would touch it at first. The species is a native of tropical America, where it extends from Louisiana to Brazil, but is found now also in tropical Africa, the Galapagos Islands, Australia and India.

In introducing Panicum Spectabile I had in view to replace the useless Hilo grass to produce an abundance of the best and most nourishing feed for the cattle that are such a detriment to our forest and the Islands at large.

In a paper just received, "Die Rinderzuucht in den zentralen Theilen Suedamerikas," Bei Dr. Rudolf Endlich (The Cattle Industry in the central part of South America), the author deals very minutely with the various grasses indigenous to that country. Panicum Fistulosum, growing on banks of rivers, and Panicum Spectabile, stand at the head of all grasses in importance as green feed, for nearly all the horses, mules and cows, in the cities of Moto Grosso are fed upon the same.

Respectfully,

A. Koebele.

Lihue, Kauai, October 11th, 1901.

Professor A. Koebele, Honolulu.

My Dear Sir:—I received your valued favor of September 24th and in reply beg to say that, I do not think, I can report anything new to you concerning cane borer. Having been short of labor this year we could not fight this pest as we would have liked to, a gang of 30 to 40 women and boys having been engaged for this purpose for about six months this summer, while in previous years from $8,000 to $9,000 was expended per season. I know of no better and more effective method of destroying this pest than the one practiced here for the last seven years, i. e. picking the beetles from young cane and later on cutting out and splitting borer effected stalks and taking out the larvae. The split cane is left alongside the watercourses and one man is sent there every three (successive) days until the pieces become dry, who will gather from 3,000 to 5,000 beetles a day.

The effect of stripping cane, as a protection against borer has also been reported to you and the condition of our stripped and unstripped cane this season again is a good proof of the fact.

Yours very truly,

F. Weber.

Kahuku Plantation, Kahuku, Oahu, October 17th, 1901.

Prof. Koebele, Chairman Committee on Diseases of Cane.

Dear Sir:—As a member of the committee on Diseases of Cane, I beg to offer the following notes as my contribution on that subject:

The Hawaiian planters have never, I believe, been seriously disturbed by the presence of any cane diseases in the islands. In fact I doubt that there is any evidence to show that there is today any cane disease here that is damaging our cane crop to an extent at all grave. We have been most fortunate here in this respect. Our good fortune lies I think, in the fact of our having a climate and soil that are not conducive to diseases of cane. Also the systematic practice of burning off the fields after the harvesting, has no doubt, tended to destroy germ life, and so prevent the increase of any disease that may have been here in its incipiency.

In searching through copies of the Planters' Monthly for ten years back, I found quite often mention of cane diseases in other sugar countries, but not once of disease in Hawaii. The Island of Mauritius, I found, is one of the worst cane disease infested countries, and examination of the map will show it to be in about the same latitude south as we are north.

We are now practically immune from any such dread disease as the Sereh Disease of Java or the Gumming Disease of Australia, but we cannot be assured that we will not fall victims to those same diseases or some other equally bad or worse if we are not constantly on our guard. I believe our safety lies first in guarding against the introduction into the Islands of diseased cane cuttings, and secondly and chiefly in the burning off of the trash immediately after harvesting, and so destroying germs and vermin.

Dr. Maxwell urgently maintained that the dry trash and tops should be conserved and returned to the soil by some device of plowing it under. The Doctor's intention here was good certainly, but I fear the practice might prove disastrous. Nitrogen is lost into the air by the burning, but so I think are cane diseases. The nitrogen we can replace, but loss by disease we cannot. I think it is preferable to go to the expense of replacing the lost nitrogen, rather than run the risk of propagating germs through not burning.

We no doubt have reason to congratulate ourselves that cane diseases are not prevalent, but some of us have had to fight a cane pest that is fearfully destructive and most difficult to eradicate, and that is the borer. Other than rats and mice, this beetle is the one single pest in the Islands, but it certainly is very serious.

Prof. Koebele has treated the subject of the borer very thoroughly, and I do not intend to go into it here, but I wish simply to state a few ideas and observations of my own in connection with the subject.

The borer, as is well known, confines itself almost exclusively to the wet or rainy districts. The commonly accepted theory I believe is that it prefers the rainy districts because the cane is soft and green and easy to attack in consequence. I do not think that close observation will bear out that theory. I have often noted here at Kahuku, that the borer has attacked an exposed and hardened stalk when right adjoining there were soft green stalks in abundance and untouched. Here this season there was a field of dry hard rattoons that was very badly damaged by borer, while an adjoining field of rank soft plant-cane was comparatively free. We lately took off the field that has formerly been one of the very worst for borer, and we found only a small percentage of cane affected, and the field was soft, rank rattoons! These facts are not easy to account for.

It is my theory that the borer beetle wants water, and that he does not like a prolonged drought, and that that explains the fact that the plantations in the dry districts are practically free from the pest. On places where there are frequent showers, so that a few drops are caught and held between the leaf sheaf and the stalk, the beetle can always find its way there and get water. It is a notable fact that the beetle when it comes out from the stalk in its matured state, can always be found behind the leaf-sheaf. It is true that it feeds there on the leaf-sheaf, but that does not dispute the theory that he is also there for water or moisture.

The upper young green leaves cannot be stripped from the stalk without injury and so the water pockets are always present. From the experience of the past year at Kahuku, it would seem that stripping was of little or no benefit as far as the borer is concerned. The fields here have always been stripped in past years, with the object of preventing the ravages of the borer, but the beetle continued very numerous and destructive all the time. This last year's crop was not stripped, through force of circumstances, but there has been no noticeable difference—it was rather the contrary. The loss by borer this season, though great, was proportionally less, in my opinion, than for most previous seasons.

For borer infested plantations the only very sure and effective way, in my opinion, to combat it and to get better returns at the same time is to take off shorter crops. Last season, from a field of plant- cane we got but two tons of sugar per acre. It was about twenty-three months old and the borers had destroyed about three-fifths of the cane. Now we can get a better yield by far from short rattoons, and in far less time. The borer is so tremendously prolific, that in allowing fields to age a great risk is taken. Short cropping will defeat the borer —short cropping and burning would eventually exterminate the borer I believe. There has got to be a sacrifice where there is borer to contend with, and to short crop is the easiest, safest and most profitable, I think.

Respectfully submitted,

W. A. Baldwin.

REPORT ON FORESTRY.

Gentlemen:—In submitting for your consideration the following remarks on Forestry, it seems to me at this particular time more necessary than ever, to direct your attention to the ever lessening area of natural-forest on our Island group.

Since the latter end of April this year, some of the islands have suffered, from, I may say, an unprecedented drought; while the districts of Hamakua and Kohala, on Hawaii, with which I am most closely in touch, have probably been victims to a greater extent than any other. The result being that to date, approximately, some thirty thousand acres of healthy and partly denuded forest, as well as other crops, have been fire swept. Although both brains and money were exercised in labor to suppress the fire, all efforts proved futile; the best that could be done was to confine its ravages within certain limits, and await the long expected rain, which finally subdued the flames.

From time to time we have noticed through the press, views of both close and casual observers on this forest question, which to say the least, are conflicting. One says, "Man has done more to reduce the forest area, through careless or wilful fire raising, than any other agency at work." Another claims "that cattle or stock are a means of protection, by their treading down any undergrowth of ferns, vines, or grass which might offer an attraction for fire, during those periodical droughts to which we are subject." While a third writes, "If forests were in their entirety protected from the ravages of cattle, fire could not get sufficient hold to destroy any great extent of forest." With the views of the latter I coincide. Not, however, as the bulk of our Hamakua forest stands today; but if it were, or ought to be, in the condition of sixty years ago, a dense growth of vegetation from the lower forest line to high up the mountain slopes, we can imagine the moisture which would be precipitated and retained, through its ameliorating influence on the atmosphere, sufficient protection from any fire. On the forest lands lying between the valleys of Waipio and Waimanu of Hamakua, Hawaii, where up to the present no cattle have been allowed to roam, the forest, though of a scrubby nature and apparently growing on soil of a later formation than that of the eastern Hamakua slopes, demonstrates the impossibility of fire ever being its ruin. In July of this year fire started close by the path leading from valley to valley, either through the careless or malicious nature of some passer-by. For several days this fire burned briskly, confining itself, however, to the coastline, where there was a sufficiency of dry grass and timber to offer it inducement. So soon as it reached the timber line proper, conditions change. The surface is moist and vegetation succulent, offering no foothold for fire. Those familiar with the district, no doubt will say that, this only could be expected in such a place, abounding with water springs and streams. To such, I can but say, and doubt it not, that in the past a similar condition existed all along the Hamakua coast, from Waipio to Ookala, where the numerous gulches now dry, indicate that they were not always thus, or made by periodical freshets carrying off superfluous water while the rains fell, but have at a distant date flowed more or less all the year round. This changed condition of affairs I can only account for by the continued grazing of cattle and other stock, to the detriment and final destruction of forests on all of the higher elevations which formed the water-conserves.

This denuding of forest by cattle or other stock has now somewhat become a stale subject, and in our limited sphere a much written of question. The rancher is ever glad for the protection of his flocks, to grasp the idea that bugs, beetles, ants or some other insects are the main causes of forest dying off; or it may be that like his stock the forest needs renewing by introduction of new blood. To a certain extent this may be so. To satisfy himself, however, that stock are the chief cause of forest depreciation, let him turn his four-year-old's loose in a patch of young forest just knee high, and watch the result. It is not so much the damage done to older trees by cattle that exhausts our forests, but the killing out of seedlings either by cropping, or treading them down, besides a general killing out of tree and ferns, which by keeping the Hilo grass under control, acts as foster-parents to any young seedlings appearing under their nursing shade, thus preventing young trees from establishing themselves to replace those maturing and decayed monarchs we find through any well grown forest.

The greater extent of our forest lands are owned by Government, and I may say with the exception of those set apart for homesteads, are let to the rancher, and in most cases under a long lease for a very nominal rental. To the heads of our local government much credit is due for some of the provisions anent tree planting included in those land grants, and if those agreements are strictly enforced will, to a great extent, preserve part of the forest which otherwise would disappear; while they also have done much to improve the symmetry of the hill slopes adjoining Honolulu; in addition to saving their already limited water supply. It seems, however, a case of "Paul planting and Apollus watering, while the Federal authorities come along and pluck it out," on seeing the late depredations committed on the higher slopes of Tantalus. This sphere of usefulness has been limited to a small area, and we look for the time when our forest department will be able to extend its work over the group, setting aside reservations for forest culture, introducing to these reservations a class of trees, more than ornamental, establishing and maintaining these plantations from their start by business-like methods, under the control of an experienced forester, then the results will eventually prove, to those interested, a paying investment.

Looking to the high price of lumber now imported to these islands, it seems time that land owners realize the necessity of being beyond the present control of manipulators in this branch of Island trade. Trees can be grown on the Islands to supply our demand for lumber in all its uses. Already the rapidity with which the silk oak (Graevillea Robusta), iron-wood, (of sorts Causirinia, Eucalyptus and Wattles in variety) have grown is demonstrated; trees of sixteen years' growth measuring at twenty feet from the base, 14 to 16 inches diameter, and can at maturity undoubtedly replace the hard-woods now used for implement or carriage manufacture. Again, of later introduction, we have the Cryptomeria Japonica and Cypressus Macrocarpa, Conifers which from every indication are likely to prove a success, and may in the future supplant the pine wood at present used for general building purposes. How many more varieties of this useful class of timber can be grown on the different elevations with success has yet to be proven, although I doubt not there are an endless variety; as well as trees and undergrowing shrubs useful for their gums and resins.

Apart from the value of forest as a timber producer we have on the Islands been more accustomed to look at it from the agriculturist's view, its bearing on the moderating of temperature, shelter to crops, and adjustment of, or regulating water supply, without which our main industry would be poor indeed. With this in view, the importance of combined efforts of the government and agriculturist being brought to bear on such a vital question as almost complete destruction of some of our finest Hawaiian forests, can be seen, saving, where practicable, what yet remains of Acacia Koa, Sandal-wood, &c. and planting up either by seed or seedlings of exotic trees, the spaces too large for the work of natural reproduction to progress rapidly. The result is not far to look for from a Government view, arable lands will have a higher taxable value, while the tiller will be better able to pay such taxes from the higher fertility of his soil, shelter from parching winds, and washing of lands when an exceptional rain storm falls on the higher elevations, or in short, not so entirely at the mercy of the elements as they would be if the country continues to become a treeless waste.

It is especially worthy of notice the interest taken in forests by some of the island sugar planters, notably that on Maui, by Mr. Baldwin, who has planted out, and still continues to do so, many thousand young trees on the higher lands adjoining his plantations, as well as fencing off large areas, in order to let nature have its sway unmolested by cattle or any other stock so detrimental to young seedlings. In the Hamakua district of Hawaii the Pacific Sugar Mill has for many years taken an active interest in forest protection, and when opportunity offered, has from time to time purchased large tracts of land for the sole purpose of raising or increasing the area of forest in the neighborhood of its cane lands and water-sources. Again we have in Kohala an example of what can be done in tree growing by visiting the estate of Dr. Wight. There the iron-woods seem to rival one another in their ambition to grow. Bare hillsides useless for other crops, have been judiciously set out with trees, hedge rows along the main and plantation roads mark the care and interest of the "rural-laird" in his love for trees.

Since coming under the wing of Federal protection we may look for some help from that direction, and if Mr. Pinchott, or some of his able assistants who are personally going through the group, I doubt not that in conjunction with our local forest department and its experience here of climatic and other conditions, will be able to offer some valuable suggestions, as well as assistance in seed and plant selections. With such help in view, let us hope the day is near when forest will be considered of more value than it now is, and that the forest fire raiser may, like other pests, have an enemy on his trail feathered in kahki. Respectfully yours,

D. Forbes,
Chairman of Forestry Committee.

SECOND REPORT ON FORESTRY.

Halawa, Kohala, Hawaii, Nov. 8th, 1901.

Regarding this great and important question of forestry, it is a subject which has been from time to time handled with greater skill and knowledge than I possess, consequently I will not enter into the scientific part of the question. I will therefore briefly confine my views to such local conditions which have frequently come under my observation.

I think we all agree that forest preservation is an absolute necessity, and that the time has arrived when we can no longer delay the preservation of such forests as we have left. Just what action is necessary to bring about this desired result, I am not prepared to say, except, that as our local Government has been very indifferent and dilatory in taking any action, or devising any plan to preserve or protect our forests in the past, we need not look for much or any action from this direction in the future.

However, the Federal Government, through its able bureau of Agriculture, and the great interest it takes in forestry, gives me great hopes that we will find in the very near future the desired attention and action fom this source.

It therefore behooves our Association to state forest conditions as they exist, and make the most urgent and strongest plea possible, to have the Federal Government look into forest conditions on these Islands, and if necessary, condemn right and left, lands for forest reservations.

In my opinion there are three most important causes which have hastened the destruction of our forests. The first by the sugar planters themselves; of late years the area of cane cultivation has been considerably increased, and the fine healthy forest growing on this land has been cut down and removed.

The second cause has been the ruinous policy of our local government in opening up such large areas of forest land for homesteading purposes. Notwithstanding the reservation clauses in the homesteaders' lease or sale, great destruction has gone on, and to such an extent that no commercial or domestic use can be found for the trees so cut down. The idea advanced by some, that coffee trees or any other green truck garden produce grown on this land, denuded of its virgin trees, taking their place, is altogether too ridiculous to take any notice of. The third and last cause is, of course, the ravages of roaming cattle. It certainly does not take them very long, when confined to a limited area of virgin forest, to beat and trample down the ferns, vines and other underbush, and in a very short time produce a fine park-like landscape, with about fifty or so trees left standing to the acre, which act as a fair shelter to the animals, but that is all, for, with the dense undergrowth of the virgin forest gone, and the closely eaten grass only remaining, we have an ideal water-proof grass carpet, from which the rain, as it falls, quickly runs off into the ravines, and when the rain storm is over, so is the supply of water, which under natural conditions would last some time and be given off gradually.

To sum up the energetic extending cane area, sugar planters should be compelled to plant at least five trees for every one he cuts down. The homesteaders should be located on open country where there are no trees, and be compelled to plant a given number, according to the acreage he takes up. The rancher and his cattle should be forever removed from all lands having a semblance of forest left, and confined to the open country, where he also would plant groves of trees for shade for his animals. Finally, everyone who has the good and prosperity of these Islands at heart, should plant trees in ravines and any waste place wherever found. By such means, sufficient water would be assured to the householders, and moisture to the agriculturist, who depends entirely on an adequate supply of water to grow his crops and to supply him with comfort and even existence.

At considerable private expense tree planting and in a small way forest preservation has been practiced here in Kohala for many years; the efforts of the pioneers in this good work is apparent today. Not only have their homes been beautified, but ravines and waste places give ample testimony of the good work done, and being steadily done.

I regret to say this practice is not as general as it might be, and no great or beneficial results will ever be accomplished until this practice becomes universal and national.

Allow me to again urge the necessity of immediate steps being taken to make forest preservation, re-foresting and tree planting generally a national issue. In order to get the public interested I would suggest the formation of an Arbor Day Society, in every district on these Islands.

LETTER FROM R. E. BLOUIN.

Louisiana Sugar Experiment Station, Oct. 24, 1901.

MR. E. E. OLDING, Kohala Sugar Company.

* * * Regarding the manufacture of sugar, I will state that in Louisiana there has been a general improvement, both with the mills and other apparatus in the sugar house. Our mills here are similar to the modern mills erected in the Islands, and as you are familiar with these, it is useless to explain them.

In clarification, we have a number of processes, using sulphur, lime and phosphoric acid as clarifying agents. In some of these the old idea of sulphuring first, then liming to about neutrality, has been carried out. Wtih others, lime has been added to quite a degree of alkalinity, and sulphured until this alkalinity was reduced to slight alkalinity, heating, and making a double sulphuration, or sulphuring again to slight acidity. With this process quite a light juice is obtained, and no difficulty experienced in getting white sugar. Again, a high sulphuration at first, followed by one application of lime to neutrality, has been carried out. With others, lime has been white sugars. With phosphoric acid, about the same combinations exist as when you were with us here on this station.

Several forms of good filters have been introduced in the sugar house, both for filtering clarified juices, and the settlings and skimmings of the ordinary clarification.

The Deming apparatus is also used to some extent, and as a rule has given satisfaction with mill juices, though it is not considered a success with diffusion juices.

In evaporating the juice to a syrup, the only new machine has been the Lillie Effect, and its results have not been as satisfactory as those in the Islands.

In boiling, there are, as you know, a number of methods carried out, some with more or less advantages. To enumerate these would be going into numerous details, some of which we question their adaptability and usefulness.

I note specially your desire for data on the utilization of waste products. Of course you are aware that our waste molasses is utilized as a source of alcohol; also that it is mixed with glucose and other products to form a palatable table syrup, and frequently bleaching is resorted to. It is also extensively used as a stock food, and as the latter has been extremely profitable.

As to the utilization of bagasse for paper making, I regret that I cannot give you any absolute data, other than mere hearsay. It is known that an equal portion of dry matter in the bagasse will produce nearly its weight of paper. By this I do not mean to say that one ton of bagasse will produce one ton of paper—or nearly that—but that one ton of the fibre contained in the cane bagasse will produce approximately one ton of paper. Paper a short while ago was worth about $3.50 per hundred pounds; prior to that it was as low as $1.45 per hundred pounds. This paper, the price of which I here quote, is the ordinary newspaper quality, which can be easily manufactured from bagasse; but at present I know of no factory making this quality of paper. There is but one factory that I am aware of, that is making paper from bagasse on a commercial scale, and that is E. H. Cunningham & Co., of Sugar Land, Texas—that is from bagasse or diffusion chips, the latter, I believe, forming his principal source of material. He has not attempted to make anything but wrapping paper, for which he has quite a ready market, and I believe has found it quite profitable.

There are several projected paper mills spoken of in this State, but as yet none are in operation. It has been demonstrated, however, that not only the paper used for newspaper purposes, and the ordinary wrapping paper, can be made of bagasse, but that any of the finer qualities of paper can be manufactured, if sufficient skill is applied.

I trust that what I have here given you will be of some assistance to you in your report, and regret that your letter has remained so long unanswered, which I assure you, however, is due to Dr. Stubbs' absence and the lateness at which it was brought to my attention. * * *

Very truly yours,

R. E. Blouin.

:o:

WORK OF THE EXPERIMENT STATION AND LABATORIES OF THE HAWAIIAN SUGAR PLANTERS' ASSOCIATION.

(R. E. Blouin, M. S., Director and Chief Chemist.)

To the Trustees and Members of the Hawaiian Sugar Planters' Association:

Gentlemen:—In this report, I have compiled the results of the experiments set out by my predecessor, Dr. Maxwell, accounts of which have been given in previous reports; and a general statement of the new work is given.

RESULTS OF RATTOONS

from crop of 1899—given in the report of that year. These experiments were conducted to bear on the question of fertilization,—the results of the plant cane were given in 1899.

The rattoons were cut back in July 1899, and continued under ordinary treatment as to irrigation, cultivation and fertilization.

The first preparation of the land has been fully described on page 4 of the report for 1899, as well as the conditions of planting, size of plats, etc. There are twenty plats, each in duplicate, the only difference being that each alternate plat is made a duplicate of the preceding, but with a different variety of cane. The odd numbered plats are Rose Bamboo, and the even numbered ones Lahaina.

The following is the fertilization used, given in pounds of each ingredient per acre and source of ingredient:

PLATS I AND 2.

179 lbs. Nitrogen per acre (from dried blood).
255 lbs. Potash per acre (from sulphate of potash).
155 lbs. Phosphoric Acid per acre (from double superphosphate).

PLATS 3 AND 4.

187 lbs. Nitrogen per acre (from sulphate of ammonia).
255 lbs. Potash per acre (from sulphate of Potash).
145 lbs. Phosphoric Acid per acre (from double superphosphate).

PLATS 5 AND 6.

179 lbs. Nitrogen per acre (from nitrate of soda).
255 lbs. Potash per acre (from sulphate of potash).
145 lbs. Phosphoric Acid per acre (from double superphosphate).

PLATS 7 AND 8.

255 lbs. Potash per acre (from sulphate of potash).
145 lbs. Phosphoric Acid per acre (from double superphosphate).

PLATS 9 AND 10.

227 lbs. Nitrogen per acre (⅓ from dried blood, ⅓ from sulphate of ammonia, ⅓ from nitrate of soda).
255 lbs. Potash per acre (from sulphate of potash).

PLATS 11 AND 12.

227 lbs. Nitrogen per acre (⅓ from dried blood, ⅓ from sulphate of ammonia, ⅓ from nitrate of soda).
145 lbs. Phosphoric Acid per acre (from double superphosphate).

PLATS 13 AND 14.

255 lbs. Potash per acre (from sulphate of potash).

PLATS 15 AND 16.

194 lbs Phosphoric Acid per acre (from double superphosphate).

PLATS 17 AND 18.

227 lbs. Nitrogen per acre (⅓ from dried blood, ⅓ from sulphate of ammonia, ⅓ from nitrate of soda).

PLATS 19 AND 20.

Unfertilized.

As before mentioned, it will be noted that each test is in duplicate, and the duplicates are of different varieties, i. e., Rose Bamboo and Lahaina. This duplication is quite valuable as it not only serves to confirm the results, but also to mark out the behavior of the different varieties when subjected to exactly the same treatment. It is also well here to refer to the quantities of fertilizing ingredients used, and compare them with those used on the first or plant crop, published in the report of the station for 1899. It will be noted that the amount of all of the ingredients has been increased, (the cause for this will be discussed in the second portion of this report) and that the relative increase of each ingredient is not the same, nor is the quantity of each source of the ingredients made such as to give exactly the same amount of the vital ingredient in each test, with the exception of potash. For instance, the amount of nitrogen used varies from 179 lbs. in plats 1, 2, 5 and 6 to a maximum quantity of 227 lbs. in plats 9 to 12, 17 and 18. Phosphoric acid, while not so variable as the nitrogen, also ranges from 145 lbs. in plats 1 and 2 to 194 lbs. in plats 15 and 16. All fertilization was applied in three applications, using exactly one-third ($\frac{1}{3}$) the amount applied per acre at each application. The dates of application were as follows:

First Application—July 26th, 1899.
Second Application—October 10th, 1899.
Third Application—March 29, 1900.

The same care was exercised in cutting, weighing, and analyzing the experiments that were observed in the previous crop and the results are in every way comparable with those of the first crop.

The following table gives the weight of cane per acre from each plat:

WEIGHT OF CANE PER ACRE.

Plat.	Rose Bamboo.	Plat.	Lahaina.
1	173,767 lbs.	2	216,679 lbs.
3	192,491 lbs.	4	272,723 lbs.
5	196,846 lbs.	6	275,276 lbs.
7	158,056 lbs.	8	148,070 lbs.
9	162,063 lbs.	10	282,204 lbs.
11	216,879 lbs.	12	203,443 lbs.
13	152,425 lbs.	14	151,135 lbs.
15	174,200 lbs.	16	115,230 lbs.
17	175,071 lbs.	18	174,200 lbs.
19	115,230 lbs.	20	137,618 lbs.
Average	171,703 lbs.	Average	197,658 lbs.

In pursuing the above table, it will be noted that there are greater variations in the weight of the cane per acre than was observed in the first crop, due both to the action of the fertilizing ingredients used, and the exhaustion of those in the soil by continuous cropping without the renewal of some or all of the ingredients.

It would be premature here to enter into an exhaustive discussion of the causes of these results, and I will have to ask your indulgence until a second report is published, which data is not yet compiled, and which, it is hoped, will give us more light upon the subject.

Further examination of the above table will be deferred until other data covering the characteristics of the cane has been presented.

The following table gives the analysis of the juice of the cane from which the sugar yield per acre will be obtained:

ANALYSIS OF JUICES.

ROSE BAMBOO.

Plat.	Density by Brix.	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.
1	16.82	15.00	.41	89.17
3	17.40	14.95	.45	85.91
5	17.50	15.50	.42	88.56
7	18.28	16.40	.21	89.71
9	17.07	15.00	.37	87.87
11	17.67	15.70	.38	88.85
13	18.67	17.00	.25	91.05
15	19.32	17.40	.24	90.06
17	18.18	16.30	.32	89.65
19	19.98	18.25	.18	91.34
Average	18 09	16 15	.32	89.27

LAHAINA.

Plat.	Density by Brix.	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.
2	17.50	15.30	.73	87.42
4	16.60	14.05	.82	84.62
6	16 60	14.30	.73	86.14
8	18.72	16.09	.39	90.27
10	17.99	15.95	.47	88.66
12	16.87	14.50	.76	85 95
14	20.38	18.30	.24	89.79
16	19.28	17.45	.32	90.50
18	17.46	15.20	.71	87.05
20	20.88	18.95	.21	90.75
Average	18.23	16.01	.54	87.82

From this data it is observed that the density, sucrose and purity are very low for Hawaiian cane juices. This was the general result last season throughout the islands, caused chiefly by the unusual rainfall in the fall and winter months. While tasseling on the rattoons was quite free, the canes kept up quite a vigorous growth, and the lack of the dry season for maturity caused the low sugar content. A very heavy weight of cane was obtained, but as before noted, it was of quite a low sugar content.

SUGAR PER ACRE.

ROSE BAMBOO.

Plat.	Pounds of Cane Per Acre.	Per Cent Sucrose in Cane.	Pounds of Sugar Per Acre.
1	173,767	13.47	23,406
3	192,491	13.42	25,832
5	196,846	13 92	27,401
7	158,056	14.72	23,266
9	162,063	13 47	21,830
11	216,879	14.10	30,580
13	152,425	15 27	23,275
15	174,200	15.62	27,210
17	175,071	14.63	25,613
19	115,230	16.39	18,886
Average	171,703	14.50	24,897

SUGAR PER ACRE.

LAHAINA.

Plat.	Pounds of Cane Per Acre.	Per Cent of Sucrose in Cane.	Pounds of Sugar Per Acre.
2	216,679	13.66	29,601
4	272,723	12.54	34,199
6	275,276	12.77	35,153
8	148,070	14.37	21,278
10	282,204	14.24	40,186
12	203,443	12.95	26,346
14	151,135	16.34	24,695
16	115 230	15.68	18,068
18	174,200	13.57	23,649
20	137,618	16 92	23,285
Average	197,658	14.30	28,265

The above table gives the final results of the fertilizer tests and are very conclusive. Before discussing the results, some explanation of the pounds of sugar yielded per acre is necessary. This, as here given, is the total amount of sugar produced by the cane per acre, and does not represent the available sugar or the amount that could be obtained from this cane in the sugar house. This amount varies considerably in the different factories and in our best factories it is not over 86 per cent of that contained in the cane. And again it will be noted that while the results generally bear out and confirm those obtained from the first crop, this being a rattoon crop, the stand was not so perfect, and in the same instances there were several vacant spaces in the experiment rows which have had influence on the results.

In comparing the action of the fertilizing ingredients on the different varieties, it is observed that the Rose Bamboo plat 11 with nitrogen and phosphoric acid gave the highest yield both in the weight of the cane per acre and in the amount of sugar produced. This is somewhat at variance with the results of the previous crop, but is fully borne out in all of the results with this variety. Plat 15 with phosphoric acid alone, while yielding a larger weight of cane than any of the plats on which nitrogen was applied, except plats 5 and 11, is practically equal to the next best result obtained from any combination of the fertilizing ingredients, and ranks a close third in the sugar yield, and all the results show a very marked increase in sugar over the unfertilized plat 19. Plat 9, nitrogen and potash, which in the last crop gave the second yield of the plats, in this crop gives the next to the lowest yield. To give the theory or reason which might apply to this would be unwise, and we will ask your forbearance until further investigation shall give us more data on the conditions. With the Lahaina, which is a more delicate cane, than the Rose Bamboo, the results are quite pronounced and as a general rule, bear out and confirm those obtained from the first crop. Plat 10, nitrogen and potash, gives highest yield both in weight of cane and sugar per acre, followed by plats 6 and 4. The only exception to be noted is the small production obtained from plats 14 and 18, which gave very good results on the first crop, and contain in one or the other the same ingredients that combined in plat 10 gave the best yield. Where these ingredients are used singly, they show a comparatively small increase over the unfertilized plat, but combined the result is very pronounced. Regarding plat 16, phosphoric acid alone, this result must not necessarily be taken as conclusive, as the stand of cane on this plat was the poorest in the experiments, and has unquestionably influenced the results. However, all of the results tend to give no increase in yield from phosphoric acid with Lahaina cane. Before concluding the comments on these tables, a more condensed table giving the average results of the fertilizing ingredients on the two varieties will be given for comparison with the results of 1899 or the previous crop from these fields.

Fertilizing Ingredients.	Pounds of Sugar per Acre.
Unfertilized	21,085
Phosphoric Acid	22,639
Potash	23,985
Nitrogen	24,631
Nitrogen and Phosphoric Acid	28,463
Nitrogen and Potash	31,008
Nitrogen, Phosphoric Acid and Potash	29,265
Lowest Yield (plat 16)	18,068
Highest Yield (plat 10	40,186

RESULTS OF PREVIOUS CROP OF PLANT CANE HARVESTED IN 1899.

Fertilizing Ingredients.	Pounds of Sugar per Acre.
Unfertilized	21,832
Phosphoric Acid	21,892
Potash	25,201
Nitrogen	25,463
Nitrogen and Phosphoric Acid	25,041
Nitrogen and Potash	27,230
Nitrogen, Phosphoric Acid and Potash	25,493
Lowest Yield (plat 20)	21,275
Highest Yield (plat 3)	29,189

From the above results it is noted that the same fertilizing ingredients gave the highest yields both in the plant and rattoon crops, i. e., nitrogen and potash, and the lowest average yield the unfertilized plats. As a whole the results from both crops are conformative, but in the rattoon crop, the results of fertilization are much more pronounced. This was expected, as the first crop had removed a considerable quantity of the fertilizing ingredients from the soil, and again the rattoon crop was fertilized much heavier than the plant crop. The small decrease in sugar per acre on the unfertilized plats from the yield these plats gave with the plant cane is quite surprising, and while many reasons can be attributed for this, it is better to defer comment until the full data of the conditions are at hand.

VALUE OF CANE TRASH AS A FERTILIZER.

The following experiments were conducted with the object of determining the value of cane trash as a fertilizer. Lahaina cane was used as seed and the land treated as follows:

Plat 2—Received lime at the rate of 2,000 pounds per acre, but no trash was applied.

Plats 5 and 8—Trash, which had been partially rotted in silo, and applied and dug in the soil three months before planting, and in a quantity resembling that given by the station crop of cane in 1899.

The following are the results:

Plat.	Fertilization.	Pounds of Cane per Acre.
2	2,000 lbs. of lime per acre	258,687
5	2,000 lbs. of lime per acre and silo trash	261,300
8	2,000 lbs. of lime per acre and silo trash	278,720

The above table gives the weight of cane per acre; the variations are not as pronounced as was expected, but before further examining, other data will be presented.

ANALYSIS OF JUICES.

Plat.	Density by Brix.	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.
2	16.79	14.60	.82	86.95
5	18.16	16.40	.51	90.30
8	17.63	15.50	.63	87.91
Average	17.53	15.50	.65	88.42

The same remarks regarding the density, sucrose and purity of these juices that were made on the previous plats are fully applicable here. Before further discussing these results the yield of sugar per acre will be given.

SUGAR PER ACRE.

Plat.	Pounds of Cane per Acre	Per cent. of Sucrose in Juice	Pounds of Sugar per Acre
2	258,687	13.11	33,914
5	261,300	14.73	38,489
8	278,720	13.92	38,789
Average	266,229	13.92	37,059

The yield of sugar while quite large in each instance is distinctly in favor of those experiments where the trash was applied. However, it should be stated that this is the first crop of sugar cane harvested or grown on this land, and while the results are quite pronounced, it is expected that as the land becomes more exhausted by continual cropping that there will be a much larger difference between the trash experiments and those where the trash has not been returned to the soil. It should also be mentioned that this soil is almost in a virgin state and the unfertilized plats, even after two crops have been removed, gave for the second crop quite a good sugar yield.

YIELD OF CANE AND SUGAR WHEN PLANTED IN ROWS AT DIFFERENT DISTANCES APART.

In these experiments Lahaina Cane was exclusively used, and the distance between the rows varied within practical bounds. Each plat was treated in exactly the same manner regarding cultivation, fertilization, and irrigation, and the results are strictly comparable.

Plat 1—The rows are four feet apart.
Plat 2—The rows are five feet apart.
Plat 3—The rows are six feet apart.
Plat 4—The rows are eight feet apart.

WEIGHT OF CANE.

Plat.	Pounds of Cane per Acre
1	203 643
2	270,010
3	216,711
4	196,747
Average	221,778

From the above it is noted that the difference in the weight of cane per acre with the different distances of the rows is considerable. The greatest difference being between plats two and four.

The plat with the five feet rows, No. 2, gives the greatest yield of cane, and the one with eight feet rows the smallest. The difference being 73,263 pounds of cane per acre.

The analysis of the juice from this cane will now be given.

ANALYSIS OF JUICE.

Plat.	Density by Brix.	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.
1	18.88	16 80	.53	88.98
2	17.90	15.95	.57	89.11
3	16.96	14.63	.80	86.28
4	16.18	14 05	.88	86.83
Average	17.48	15.36	.69	87.88

Here again as throughout the crop the sucrose is low for Hawaiian conditions.

YIELD OF SUGAR.

Plat.	Pounds of Cane per Acre.	Per Cent of Sucrose in Cane.	Pounds of Sugar per Acre.
1	203,643	15 09	30,730
2	270,010	14.33	38,692
3	216,711	13.14	28,476
4	196,747	12.62	24,829
Average	221,778	13.80	30,682

Here the yields show very great differences. The five feet rows, Plat 2, gives quite a large increase in sugar per acre (practically four tons) followed by the four, six, and eight feet rows in order named. Most of the cane rows on the islands are five feet, and these experiments show very forcibly that this is the most economic and advantageous distance to plant. The five feet rows besides giving both the largest weight of cane and yield of sugar also gave a juice of higher purity than any of the other plats, though the advantage in this respect over plat 1, four feet row, is very small, and the percentage of sucrose in plat 1 is greater.

Local conditions will have to be considered in the absolute determining of the distances between the rows, but every effort should be made to have them conform as nearly as possible to the five feet rows.

IRRIGATION EXPERIMENTS.

In testing this question, special attention was directed to the time and amount of water used. In the report for 1899, attention is called to the vitality of the cane under different applications of water at regular periods, and now the final results of these experiments are given together with others closely allied to them.

Plat 21 received one inch of water per week.
Plat 22 received one inch of water per week.
Plat 23 received two inches of water per week.
Plat 24 received two inches of water every two weeks.
Plat 25 received three inches of water every week,
Plat 26 received three inches of water every three weeks.

While these are the general plans of irrigating, the natural causes, such as rainfall, etc., have made a deviation from this plan necessary, and on pursuing the irrigation table here given, it will be noted that these experiments were only generally carried out and that the relative proportion of irrigation water applied is somewhat different from that outlined in the statement of the experiments. However, these experiments are comparative, and the results are very interesting.

The increase in water applied at different periods and the cause for this has been fully explained in the report for last year, and will not be repeated here.

WATER USED DURING THE PRODUCTION OF THE CROP.

Time of Application.	Rainfall.	Irrigation Water					
		Plat 21.	Plat 22.	Plat 23.	Plat 24.	Plat 25.	Plat. 26
1899	In.	In.	In.	In.	In.	In.	In.
June	0.70	4.0	3.0	7.0	3.0	10.0	4.0
July	0.17	4.0	5.0	8.0	10.0	12.0	9·0
August	1 40	4.0	4.0	8.0	.....	12.0	......
September	0.71	6.5	6.0	12.0	10.0	18.0	6.0
October	2.92	6.0	6.0	10.0	......	15.0	6.0
November	0.49	5.0	5.0	10.0	6.0	15.0	3.0
December	1.70	5.0	5.0	10.0	4.0	15.0	6.0
1900							
January	0.74	4.0	4.0	8.0	4.0	12.0	3.0
February	0.90	6.5	6.5	11.0	4.0	16.5	6.0
March	1.35	6.0	5.0	10.0	8.0	15.0	6.0
April	4.41	2.0	2.0	4.0	.....	6.0	3.0
May	1.32	8.0	6.0	12.0	8.0	18.0	6.0
June	0.54	9.0	8.0	14.0	8.0	21.0	12.0
July	2.38	10.0	9.0	10.0	8.0	15.0	6.0
August	1.68	8.0	9.0	8.0	12 0	12.0	12.0
September	1.45	10.0	8.0	10.0	8.0	15.0	6.0
October	6.99	7.0	3.0	8.0	4.0	12.0	6.0
November	11.11	1.0	1.5	2.0	......	3.0	.....
	40.96	106.0	96.0	162.0	97.0	242.5	100.0

The fertilization of these plats was somewhat different from the fertilization of any of the other plats given, and forbears comparison with any except themselves. In fertilizing only nitrate of soda and sulphate of potash were used, and the following are the number of pounds of each fertilizing ingredient used per acre:

Plat 21—138.6 lbs. nitrogen from nitrate of soda and 156.8 lbs. of potash from sulphate of potash.

Plat 22—133.4 lbs. nitrogen from nitrate of soda and 157.5 lbs. potash from sulphate of potash.

Plat 23—The same fertilization as 21.

Plat 24—Fertilized as Plat 22.

Plat 25—Fertilized as Plat 21.

Plat 26—Fertilized as Plat 22.

The preparation and cultivation of these plats were identical, and the same as given to the plant cane in the crop of 1899.

WEIGHT OF CANE.

Plat.	Pounds of Cane per Acre.
21	332,728
22	284,882
23	390,080
24	328,657
25	285,343
26	226,170
Average	307,977
Average of one inch weekly	308.305

This table gives us the weight of cane harvested per acre. The results are very pronounced, and the yield of cane very large. While here, it should be noted that this crop is from practically a virgin soil that had been quite liberally fertilized and that the yield is further enhanced by the conditions previously noted as prevailing last season.

Following this the data covering the analysis of the juice from the cane will be given:

ANALYSIS OF JUI ES.

Plat.	Densisy by Brix.	Sucrose in Juice.	Glucose in Juice.	Purity of Juice.
21	17.97	15.98	.58	88.93
22	19.68	17.70	.35	89.93
23	17.77	15.60	.70	87.78
24	16.70	14.40	.73	86.22
25	17.87	15.75	.73	88.13
26	17.77	15 70	.69	88.35
Average	17.96	14.23	.63	88.25

The juices are near the average of those of the preceding experiments given in this report and are low for Hawaiian conditions, due to the same causes as previously given.

The following table gives a compilation of the results of these plats, and also the sugar produced per acre.

SUGAR PER ACRE.

Plat.	Pounds of Cane per Acre.	Per Cent of Sucrose in Cane.	Pounds of Sugar per Acre.
21	332,728	14.30	47,580
22	284,882	15.89	45.268
23	390,080	14.01	54,605
24	328,657	12.93	42,505
25	285,343	14 14	44,387
26	226,170	14.10	31,890
Average	307,977	14.23	43,825

Before discussing these results, an additional explanation regarding the sugar yield per acre should be noted. As before stated in this report all of the sugar yields give the number of pounds of sugar actually produced per acre, and not the number of pounds that should or would be produced in the manufacture of sugar from the cane. This is a varying quantity, and is not greater than 86 per cent of that produced by the cane even in our best sugar houses. This is repeated here so as to avoid any errors that might be made in an examination of the above tables.

These results are pronouncedly in favor of the application of two inches of water weekly. The other applications of water, with the exception of plat 26, where the interval between irrigations was three weeks, while showing considerable variation in the weight of cane per acre are closely allied in sugar yield. Special attention should be called to plat 24, where there was two inches of water applied every two weeks. This plat gave a very good weight of cane, but the sugar content of the cane is markedly low, bringing the sugar produced per acre somewhat below that of the other plats receiving the same amount of water. With this plat and plat 26 the only plats where an interval of over one week elapses between irrigations, the results conclusively condemn the extension of the intervals between irrigation beyond the weekly period. These experiments have been continued, and while the results are now quite pronounced, it is expected that much more light will be thrown upon the subject of irrigation by these and other experiments now being carried on.

IRRIGATION.

Owing to the variation in the amount of water applied to the different crops harvested this year, it has been deemed advisable to separate the irrigation of each character of experiments and discuss these under separate headings from the primary object of the test which has been given before.

The following table gives the water used on the rattoon crop:

WATER USED DURING THE PRODUCTION OF RATTOON CROP

Time of Application.	Rainfall.	Irrigation Water.
1899.	Inches.	Inches.
July	0.08	3.0
August	1.40	5.0
September	0.71	5.0
October	2.92	5.0
November	0.49	5.0
December	1.70	4.0
1900.		
January	0.74	3.0
February	0.90	3.0
March	1.35	3.0
April	4.41	1.0
May	1.32	4.0
June	0.54	6.0
July	2.38	7 0
August	1.68	6.0
September	1.45	7.0
October	6.99	3.0
November	11.11	1.0
	40.17	71 0

Before entering into a discussion of irrigation, the other application of water given to the plant crop under the general headings, value of cane trash, rows of different distances will be noted, both experiments being with Lahaina plant cane.

WATER USED DURING THE PRODUCTION OF THE PLANT CANE CROP.

Time of Application.	Rainfall.	Irrigation Water
1899.	Inches.	Inches.
June	0.70	3.0
July	0.17	4.0
August	1.40	5 0
September	0.71	5.0
October	2.92	3 0
November	0.49	5.0
December	1.70	5.0
1900.		
January	0.74	3.5
February	0.90	3.0
March	1.35	5.0
April	4.41	.....
May	1.32	5.5
June	0.54	8.0
July	2.38	9.0
August	1.68	7.5
September	1.45	9.0
October	6.99	5.0
November	11.11	1.0
	40.96	86.5

There is some difference between the irrigation of the plant and rattoon crops and the period of growth for the plant crop is somewhat longer giving a longer period of irrigation and a slight additional rainfall. The rainfall, of course, fell alike over all crops, but the irrigation and rainfall on the rattoon crop includes only that after the cutting back of this crop in July. While the rainfall during the growing period is very near the average, the greater part of the growing period rainfall was much below the average. Of the 40 inches rainfall 18 inches fell during October and November, at which time the crop is nearing maturity and requires very little water.

The following table gives the rainfall and irrigation water of the different crops:

Year.	Rainfall. Inches.	Irrigation Water. Inches.	Total Water. Inches.
1897-1898	46 5	47.0	93.5
1898 1899	26.9	76.0	102.9
1899-1900 Rattoons	40.17	71 0	111.17
1899-1900 Plant	40.96	86 5	127.46

To this another table giving the rainfall and irrigation water used in the irrigation experiments will complete our data covering the application of water to the crop of 1899-1900.

Experiment.	Rainfall. Inches.	Irrigation Water. Inches.	Total Water. Inches.
Plat 21	40.96	106.0	146.96
Plat 22	40.96	96.0	136.96
Plat 23	40.96	162.0	202.96
Plat 24	40.96	97.0	137.96
Plat 25	40.96	242.5	283.46
Plat 26	40.96	100.0	140.96

From these tables we have quite a range in the amount of water used in the different crops, from 93.5 inches in the crop of 1897-98 to 283.46 inches, the maximum amount of water used during the growth of the present crop. Another table giving the number of gallons of water used per acre by the different crops will present this matter in a more definite light.

GALLONS OF WATER USED PER ACRE BY THE CROPS.

Year.	Rainfall. Gallons.	Irrigation Water. Gallons.	Total Water. Gallons.
1897-1898	1,263,870	1,277,460	2,541,330
1898-1899	731,142	2,065,680	2,796,822
1899-1900 Rattoon	1,091,821	1,929,780	3,021,601
" Plant	1,113,293	2,351,070	3,364,363
" Plat 21	1,113,293	2,734,308	3,847,601
" Plat 22	1,113,293	2,609,280	3,722,573
" Plat 23	1.113.293	4,402,160	5,515,453
" Plat 24	1.113.293	2.636.460	3,649,753
" Plat 25	1,113,293	6,591,150	7,704,443
" Plat 26	1,113,293	2,718,000	3,831,293

This water was used during the growing season of the crops which covered 17 months during the crops of 1897-1898, 1898-1899 and the rattoon crop of 1899-1900, while the other experiments in the crop of 1899-1900 the period of growth covered 18 months.

The following table will further assist in determining the efficiency of the action of water on the various crops:

NUMBER OF GALLONS OF WATER USED PER POUND OF SUGAR PRODUCED.

Year,	Gallons of Water used per Acre.	Pounds of Sugar Produced per Acre.	Gallons of water used per pound of Sugar.
1897-1898	2,541,330	24,755	102 7
1898-1899	2,796,822	29,059	96.2
1899-1900 Rattoon	3,021,601	26,581	113.7
" Plant	3,364,363	30.682	109.3
" Plat 21	3,847,601	47,580	80.9
" Plat 22	3,722,573	45,268	82.2
" Plat 23	5,515,453	54,605	101.0
" Plat 24	3,649,753	42,505	85 6
" Plat 25	7,704,443	44,387	173.5
" Plat 26	3,831,293	31,890	120.1

In giving the efficiency of water in the production of sugar in the above table, average yields have been taken. It has been shown that the fertilization of the plats has quite a marked effect on the quantity of sugar produced, and in like manner, on the amount of water required to produce a given weight of sugar. Besides this, the varying climatic and local conditions largely influence the amount of water utilized. To further present this matter, the following table giving the maximum sugar yield per acre with the amount of water utilized will enable us to compare conditions from a different standpoint.

Year.	Gallons of Water used per Acre.	Pounds of Sugar per Acre (Maximum).	Gallons of Water used per Pound of Sugar.
1897-1898	2,541,330	29,189	87.1
1898-1899	2,796,822	34,395	81.3
1899-1900 Rattoon	3,021,601	40,186	75.2
" Plant	3,364,363	38,692	86.9
" Plat 23	5,515,453	54,605	101.0

The maximum service of water is here shown in the rattoon crop of 1899-1900 requiring 75.2 gallons of water to each pound of sugar produced. While this shows the maximum production of sugar from a limited supply of water, the question presents itself, "Is this the most profitable use of water?" This needs no discussion to answer it. By referring to the above table, and asking whether 2,500,000 gallons of water cost more than 14,000 pounds of sugar (using round numbers) it is easily answered, and it is well seen that the extra application of water is extremely profitable.

The variation in the amount of irrigation water used during the various months of the growth of the crop, and the causes for this have been fully explained in the report for the previous crop and a repetition here would occupy unnecessary space.

STATION WORK.

The writer desires to express his gratitude to the valuable assistance received from the employees of the station during the short stay in the islands. The laboratory work was performed by Mr. C. F. Eckart, first assistant, and Mr. S. S. Peck, second assistant, and has been a very valuable and gratifying aid in the pursual of these investigations; and the excellent services of Field Assistant, Mr. E. G. Clarke, have been of great assistance.

It is with extreme regret that the data are not available to complete this report. But it is hoped that the issuing of a second report in a short time will be of interest and a useful conclusion to the results here given.

NEW WORK.

The experiments on fertilization have again been planted and will be continued along the same lines, also those of irrigation, except in the latter ordinary fertilization will be followed. Experiments enlarging the sources of fertilization ingredients have been started, also with the view of determining the maximum amount of each ingredient both collectively and separately that can be economically utilized by the cane, and the manner and form of its distribution.

The value of the application of organic matter to the soil is being investigated, both as to the value of cane trash returned to the soil and green manuring by leguminous plants.

Experiments on the influence of salt on the growth of the cane, and absolutely determining the limit of it in the irrigation waters are under progress and indications point to very pronounced results.

The value of stripping cane is also under investigation and will be thoroughly determined. With these experiments there is also a test as to the comparison in sugar yield of a crop of one year's growth with the normal crop (18 months.) Both crops being of plant cane.

The report on fertilizers will be presented by Mr. Eckart and will fully cover the work at the station in this important branch.

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REPORT ON FERTILIZATION.

(C. F. Eckart, Chairman of Committee.)

Honolulu, H. T., November 18th, 1901.

To the President, Trustees, and Members of the Hawaiian Sugar Planters' Association,
Honolulu, T. H.

Gentlemen:—During the past year, no less than twenty-five thousand tons of commercial fertilizers have been added to our Hawaiian soils to satisfy the demands of the sugar industry.

The initial cost of this large quantity of fertilizing material, added to the cost of distribution and application, makes the subject of fertilization from an economic standpoint one of great importance and worthy of close consideration. The comparative cost of the different manurial compounds, their relative efficacy in meeting the requirements of the cane crop, their proportional liability to waste under given climatic conditions, combined with a knowledge of the soil to which they are to be applied, must constitute the only basis from which any rational and economical system of fertilization can be derived.

The earliest method in use for determining the ability of a soil to furnish the requisite amount of plant food for a given crop, involved practical tests with small field plats. On a small area, without fertilization, but with due observance of proper tilth and cultivation, a crop was started for purposes of comparison. At the same time other plats were laid off in the same field and received alotments of nitrogen, phosphoric acid, lime, potash, etc., and the effect of each one of these applied elements was carefully noted as regards any increase of the given crop over and above that on the unfertilized area. Not only were these fertilizers added separately on some plats, but in mixtures of varying proportions on others, and valuable conclusions were reached as to the demands of the plant. These practical tests are still carried on to a large extent in some agricultural communities, and results are reached of sufficient value to more than compensate the farmer for time and labor expended.

These plat experiments, however, are found to be open to the following objection: The time necessary to determine the proper quantity and the best balanced proportion of fertilizing ingredients to be added for maximum yields, covers periods of considerable length.

The chemist has endeavored to overcome this objection, and to reach in the laboratory results that have taken the agriculturist months to learn from observation in the field. By an examination of the ash of the particular plant to be grown, he learned the quantities and proportions of the various mineral elements that had been removed from the soil, and used in the development and elaboration of the plant and its products. He digested a small quantity of the soil in hydrochloric acid of a certain specific gravity, and noted the percentages of the different elements in the resulting soil extract. From these analyses, conclusions were drawn as to the fertility of the land in question, and the supply of plant food, from which the crop could draw as needed, was supposed to have been measured.

Unfortunately, discrepancies soon begin to arise between field results with the growing crop and the conclusions reached from chemical analyses, and the chemist found that his shorter method was not without palpable defects. If an element was lacking in the soil or was present in very small quantity, he felt safe in recommending the application of that element in fertilization, but where an ingredient was present in large amounts, he sometimes found that that self-same element was one to be added in manurial mixtures for satisfactory results. In other words elements can be present in large amounts in the soil, but in a state which renders them unavailable to the plant. Regarding the ordinary agricultural method for determining soil deficiencies, this may be said in its favor: That in some instances it serves as a valuable guide in fertilizer recommendations, when the chemical analysis is supplemented with reliable data as regards the physical condition of the soil, combined with a knowledge of the climatic conditions of the locality from which the sample has been obtained.

In view of the objection which has been mentioned regarding the agricultural method, investigators have endeavored to find an acid more suitable for soil digestion than hydrochloric, and one whose solvent action would be more comparable with the acids of the plant roots. Organic acids were substituted for mineral acids in the experiments, and a long stride was taken towards the solution of this important problem.

Aspartic Acid Method.—This method of determining the availibility of the plant food in the soil, is the one at present in use at the Experiment Station, and a few words may be said in regard to its practicability for Hawaiian conditions. The credit for this system of soil investigation belongs to Dr. Walter Maxwell, the former director of the Experiment Station, and Mr. J. T. Crawley, and is the result of a close and scientific study of conditions obtaining on these islands. A detailed account of the work along this line and the logical conclusions drawn from the same, may be found in an article on "Lavas and Soils of the Hawaiians Islands," published by Dr. Maxwell in 1898, and in this report only a brief reference to the deductions will be made.

The amount of mineral matter being carried into the sea by waters of discharge from the land was determined with the following results:

Hawaiian Waters.

Lime	0.0013 Per cent
Potash	0.0005 Per cent
Phosphoric acid	0.0001 Per cent

These figures represent the average mineral content of Hawaiian waters collected at many places considered suitable for such observations.

An analysis was made of upland cropped and corresponding virgin soils, the average results being as follows:

UPLANDS.

Elements	Virgin	Cropped	Loss
	Per cent.	Per cent	Per cent.
Lime	0.415	0.248	40.20
Potash	0 324	0.270	16.60
Phosphoric Acid.	0 248	0.243	2.02

The term cropping as applied to the above table is used in a very general sense. It includes the action of rain, cultivation, and growing crops in removing plant food from the soil.

Data were obtained which showed that in one case where 7,000 lbs. of lime were removed per acre, only about 15 per cent of this amount had been utilized by the crop itself, and in respect to potash the crop took only one-half of the amount removed by total cropping. "These data show that any system of judging of the depletion or of restoring the fertility of soils, that is based upon a mere calculation of the amounts of the elements that are carried away from the land in crops, is devoid of any approach to the actual facts of the matter." The reason that upland virgin and cropped soils were taken for this comparison, was on account of the washing action of the rains. The makai soil receives a large part of the wash from the mauka lands, and in some instances cropped soils on the lower lands show a higher proportion of given elements than the virgin. The amount of lime removed by cropping is 40.2 per cent, and if this is taken as a standard, applying it also as a basis for the waters of discharge, the relations existing between it and the other elements may be tabulated as below:

Elements Removed from the Soil in Water.			Elements Removed from the Soil by Cropping.		
Lime	Potash	Phosphoric Acid	Lime	Potash	Phosphoric Acid
Per cent. 40.2	Per cent. 15.1	Per cent. 2.80	Per cent. 40.2	Per cent. 16.6	Per cent. 2.02

As Dr. Maxwell has pointed out, these results do not appear so remarkable, when it is considered that the great bulk of matter removed by total cropping is found in the waters of discharge.

With these data at hand, the next step was to find some acid whose solvent action on the soil would remove the essential elements in proportions approximating those of cropping. Many organic acids of different strengths were allowed to act on the soil for varying lengths of time, and it was found that an one per cent solution of aspartic acid, when shaken with the soil at intervals during twenty-four hours, apparently met all requirements. The amounts and proportions of the elements, removed by this acid during twenty-four hours, were approximately the same as were removed by total cropping during a period estimated at twenty years. Dr. Maxwell's conclusions were stated as follows: "An one per cent solution of aspartic acid takes out of Hawaiian soils in twenty-four hours, the same amounts of lime, potash, and prosphoric acid, that are removed during the production of ten crops of cane. Therefore one-tenth of these amounts may be taken as the proportions of lime, potash, and phosphoric acid that are available for the immediate crop of cane." The Aspartic Acid Method, although not perfect, offers a fairly reliable means for determining the amount of available plant food in the soil, and is in fact a better guide in the matter of fertilization on these islands than any other known method, as in its conception, Hawaiian conditions influenced every consideration.

Before considering the subject of fertilization in its more restricted sense, i. e. the application of different manurial compounds to the soil, probably a few words on the average availability of the essential elements in question might prove of interest.

Availability of Elements.—Considerable data are at hand to give an adequate idea of the amounts of lime, potash, phosphoric acid and nitrogen that are present in the soils of the respective islands, the subjoined table representing average results of about one hundred analyses.

ISLAND	Lime	Potash	Phosphoric Acid	Nitrogen
Oahu	0.380	0.342	0 207	0.176
Kauai	0.418	0.309	0.187	0.227
Maui	0.395	0 357	0.270	0.388
Hawaii	0.185	0.346	0.513	0.540

These results were obtained by the ordinary agricultural method, which was in use at the Experiment Station prior to the adoption of aspartic acid as a soil solvent, and although an absolute analysis would give somewhat larger results, these are comparative to a large extent as showing the proportions of lime, potash, phosphoric acid, and nitrogen present in the island soils.

The amounts of the mineral ingredients which are found to be available are as follows:

ISLAND	Lime	Potash	Phosphoric Acid
	Per cent.	Per cent.	Per cent.
Oahu	.01568	.00256	.00012
Kauai	.01367	.00249	.00013
Maui	.01764	.00312	.00012
Hawaii	.00789	.00156	.00014

or reducing these percentages to a more tangible form, we have:

ISLAND	Lime	Potash	Phosphoric Acid
Oahu	549 lbs.	89 lbs.	4 2 lbs.
Kauai	478 "	87 "	4.5 "
Maui	617 "	109 "	4.2 "
Hawaii	276 "	54 "	4.9 "

which quantities represent the amounts of the essential mineral elements, in one acre of soil to a depth of one foot, that are in a condition to be removed through the several actions of total cropping, during the growth of one crop.

It is interesting to note that Kauai stands highest in lime, Maui in potash, and Hawaii in phosphoric acid. The smallest percentage of lime is on Hawaii, while Kauai is lowest in potash and phosphoric acid.

If, however, we consider the availability of these elements instead of the actual amounts in the soil, a somewhat modified order presents itself: Maui and Oahu are both higher in available lime than Kauai, Oahu standing first. Maui with the highest total content of potash has also more of that element in an available form than the other islands. The amounts of available phosphoric acid show little variation, notwithstanding a difference between .187 per cent total phosphoric acid on Kauai, and .513 per cent on Hawaii. This latter ingredient is so closely bound up in iron and aluminic compounds as to be practically insoluble; on Hawaii nine tons of the element per acre scarcely yield five pounds in an assimilable form.

Having considered the method in use for gauging the availability of the mineral elements in question, and having noted the amounts in which they are present in the soils of the respective islands, we will next consider the demands of the crop.

ELEMENTS REMOVED BY THE CROP.—In the report of the Experiment Station for 1900, it was pointed out that where 29,610 lbs. of sugar were produced per acre by Lahaina cane, 6,606 lbs. of mineral matter were extracted from the soil, while with Rose Bamboo, 30,475 lbs. of sugar required 7,662 lbs. of mineral matter. The following table shows the amounts of the various elements including nitrogen, which were required to produce one ton of sugar by the respective varieties:

Varieties	Nitrogen	Phosphoric Acid	Potash	Lime
Lahaina	25.4 lbs.	16.0 lbs.	89.5 lbs.	28.7 lbs.
Rose Bamboo	40 5 "	13.6 "	114.2 "	34.8 "

If we should take five tons of sugar per acre, as the average production for the Hawaiian Islands, and consider for our purpose that the amounts of the essential elements required by the crop for such a yield would be the same as at the Experiment Station, we have:

Nitrogen, Phosphoric Acid, Potash, and Nitrogen Required by the Cane to Produce Five Tons of Sugar

Varieties	Nitrogen	Phosphoric Acid	Potash	Lime
Lahaina	127.0 lbs.	80 lbs.	447.5 lbs.	143.5 lbs
Rose Bamboo........	202.5 "	68 "	571.0 "	174.0 "

As it is our present purpose to consider crop requirements in general, and not the special demands made by particular varieties, we will take the mean of the figures presented above, as representing Lahaina and Rose Bamboo needs, and for future consideration say, that a crop to produce five tons of sugar, would require per acre, about:

164.7 lbs. of nitrogen.
74.0 lbs. of phosphoric acid.
509.2 lbs. of potash.
158.7 lbs. of lime.

We will next compare the amounts of available elements in the soils of the respective islands, with the amounts of these elements that would be required by a crop producing five tons of sugar. The nitrogen contents of the lands are not given, as at the present time we have no reliable method for determining its availability.

ISLAND	Lime in soil	Lime required by crop	Potash in soil	Potash required by crop	Phosphoric Acid in soil	Phosphoric Acid required by crop	Nitrogen required by crop
	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds	Pounds
Oahu	549	164.7	89	509.2	4.2	74	32.9
Kauai.	478		87		4.5		
Maui.......	617		109		4 2		
Hawaii.	276		54		4.9		

It will be noticed from the above figures that lime is the only one of the elements that would appear to be present in sufficient quantity for the needs of the crop. But when we consider the statement previously made, concerning the small proportion of lime that is taken up by the crop on some upland soils as compared with the proportion removed by the other factors involved in total cropping, we may see that the average lime content is not so large but what we must consider it very carefully. Maui stands highest in available lime, having 617 lbs. on an average to the acre, but if only 15% of that amount could be utilized by the crop, as in the instance above referred to (which was most likely an extreme case), only 92.55 would go to the crop where 164.7 lbs. were needed. Even if the cane gets on an average 30 per cent of the lime removed, but small margin would be left on Maui, above actual crop requirements, while on Oahu there would be just enough, and on Kauai and Hawaii a marked deficiency.

The potash is found to be very much too low on all the islands for supplying the wants of the cane, and it is readily seen why it was found necessary, during recent years to increase the proportion of that element in fertilizers applied.

Concerning phosphoric acid, the dearth of this element in available quantities in our island soils is very apparent, but we are almost convinced that the aspartic acid method for soil analysis would indicate this ingredient to be lower in availability than it really is.

In the consideration of the amount of plant food taken from the soil by the growing crop, in order to produce one ton of sugar, we took an average of the quantities removed by Lahaina and Rose Bamboo varieties, as giving a fair idea of the large demands made by the cane upon the soil. However these proportions and amounts are not to be taken as representing the exact requirements of the cane in any locality or under any conditions. At the Experiment Station, the figures in question were reached in a comparative test of thirteen varieties of cane, grown under similar conditions as regards soil, fertilization, and climate, one of the objects being to note their respective drafts on the soil as compared with their value as producers of sugar.

Mineral Matter Returned to the Soil in Cane Refuse.—The last table, although it gives an idea of the amount of plant food that would be required for a crop of such size as was under consideration, does not show the quantities of lime, phosphoric acid, potash and nitrogen, that are taken away from the field. If it did, the application of artificial manures from crop to crop would reach much larger proportions than it really does. As a matter of fact, after the cane is cut for the mill, and the trash and dead canes, etc., are burned, as is most generally the case on plantations, a much larger amount of mineral matter is returned to the soil than is generally supposed. By burning, of course, all the nitrogen is lost with its corresponding manurial value, but the other essential elements remain on the field to be used largely by the succeeding crop.

The following figures indicate the relative amounts of the elements found in the tops, etc., and in the cane, per ton of sugar grown at the Experiment Station.

ELEMENTS REMOVED FROM SOIL PER TON OF SUGAR PRODUCED.

ELEMENT	In tops, leaves, and dead canes.	In cane
Lime	27.9 lbs.	3.7 lbs.
Phosphoric Acid	6.5 "	8.2 "
Potash	66.5 "	35.3 "
Nitrogen	20.2 "	12.7 "

These results show the lime in the tops, etc., to be over seven times that in the cane; the phosphoric acid is more evenly balanced; while the tops, etc., have nearly twice as much potash as the cane. It is thus seen that if only one-half of the mineral matter in the refuse of the field is conserved, a manurial mixture is added to the soil of particular value, which would lessen to a large extent the amount to be applied during regular fertilization.

In regard to the comparative availability of those elements returned to the soil through the burning of the trash, and the same added in ordinary fertilization, there is some difference in favor of the latter. The potash in the ash is chiefly in the form of chloride, with a smaller amount as carbonate and silicate, and the chloride is as assimilable as any that could be added in manurial mixtures. The phosphoric acid is returned to the land as iron and aluminic phosphates with a much smaller amount as phosphate of lime, and phosphate of magnesia. These phosphates are more insoluble than those generally added in fertilizers and are not immediately available to the plant. The lime in the ash is most likely combined with silica, phosphoric acid, and sulphuric acid and is only slightly soluble.

Forms in which Fertilizing Ingredients are Applied.—The amount of available plant food in the soil and the probable requirements of the crop to be grown are important factors to be considered in any estimation of manurial needs. However, unless these data are supplemented by a knowledge of climatic conditions, and a proper regard shown for their several influences, analytical investigations in respect to the nature of the soil are often of little value.

To the action of the heavy rains of the uplands in washing away the more soluble ingredients of the soil we have already referred. These rains not only leach out material which is gradually being rendered available for plant needs, but also that which is artificially applied in the form of fertilizers. The erosive action on the natural material of the land cannot be controlled, but with a due consideration of the physical and chemical properties of applied ingredients, we can place in the soil those substances required by the plant, and in a form least liable to waste.

We now come to a consideration of the elements themselves, the relative efficacy of their various combinations, and the conditions that influence their selection as component parts of manurial compounds for different locations.

NITROGEN.—This element is applied to the land in three forms, namely as nitrate of soda, sulphate of ammonia, and organic substances.

Nitrate of soda is the most soluble of these three forms and besides holds its nitrogen in the most assimilable condition. Solubility and availability are not necessarily synonomous expressions as regards nitrogen compounds, although the latter condition is greatly influenced by the former. The solubility of nitrate of soda is influenced by the temperature of the solvent, at 78° Fahr., 100 parts of water dissolve 90.33 parts of nitrate. Added to this extreme solubility is an unfortunate disinclination of the acid part of the salt to become fixed in the soil, which causes its use on some lands to be attended by considerable risk on account of the leaching action of the rains.

A test was conducted at the Experiment Station in 1898 to determine the relative liabilities to waste of nitrogen in the form of nitrate of soda, and the same element in the form of sulphate of ammonia. In one instance 200 grams of nitrogen as nitrate of soda and in another the same amount as sulphate of ammonia were added to corresponding soils draining into a lysimeter. Forty-eight hours after the application of these compounds, a copious irrigation was allowed to over-saturate the soil, and the excess of water was collected in a receiver and analyzed. The loss in nitrogen is seen by the following table:

Forms	Nitrogen Applied	Nitrogen lost in water	
		As Nitrate	As Ammonia
Nitrate of Soda	200 grams	72.56 grams	0.00 grams
Sulphate of Ammonia....	200 "	3.08 "	0.44 "

The loss of nitrogen from nitrate is very large. Of the nitrogen from sulphate of ammonia only a minute proportion was found in the receiver, the major part of this small quantity being in the form of nitrate, into which state it had been converted by the nitrifying organisms of the soil.

Mr. J. T. Crawley, of the Committee on Fertilization, conducted a number of interesting experiments during the first part of this year, for the purpose of obtaining data as regards the retentive power of "sandy soils" for fertilizers and water, and his results are of particular value in a consideration of the subject in hand. Four soils varying in their proportions of lime carbonate from 71.25 per cent to 91.07 per cent were placed in iron pipes two feet six inches long and one inch in diameter, the pipes being filled to within six inches of the top. One gram each of ammonium sulphate, nitrate of soda, and muriate of potash were dissolved in a liter of water and 500 cubic centimeters of this solution holding one-half gram each of the salts mentioned were poured upon the soils and allowed to drain through. It was found in regard to the nitrate of soda that practically none was retained by any of the soils, while the other compounds were fixed in an inverse proportion to the lime carbonate content of the medium through which they filtered. In a consideration of the action of sulphate of ammonia and sulphate and muriate of potash when applied to the soil, we shall have occasion to again refer to Mr. Crawley's interesting experiments.

The readiness with which nitrate of soda may be taken up by excessive rains or irrigation and carried from the land is readily seen, but bound up with this question is another of almost equal importance. When the nitrate is lost from the land through the over-saturation of its soil, not only so much nitrogen is lost, but likewise a large amount of lime. The nitric acid of the nitrate on coming in contact with the lime of the soil, forms lime nitrate, which is almost as easily soluble and as readily washed out as the nitrate of soda.

To observe this action of nitrate on lime, as well as the relative action of different salts in the same particular, tests were made at the Experiment Station in connection with other lysimeter investigations. Nitrate of soda, chloride of potash, ammonium sulphate and sulphate of potash were applied to the rows of cane growing over the lysimeter drains, and forty-eight hours later these rows were irrigated with 102 gallons of water, of which quantity 33 gallons leached out and was analyzed.

Drain	Salt applied	Lime Lost
No. 1	None	1.72 grams
No. 2	Nitrate of Soda	26.52 "
No. 3	Chloride of Potash	23.49 "
No. 4	Sulphate of Ammonia	5.49 "
No. 5	Sulphate of Potash	2.73 "

The lime taken out through the influence of nitrate is seen to be extremely high.

We have spoken at some length concerning the unfavorable characteristics of nitrate of soda when applied to lands of heavy and uncertain rainfall, particularly when such lands are deficient in lime. However, notwithstanding these several draw-backs to its general use in all localities, nitrate of soda has sufficient superior qualities when applied in proper quantities and under suitable conditions to render its use of the highest advantage.

When applied in large amounts and under such conditions as to allow of the fullest effects, nitrate has been observed in many instances to induce an abnormal and undesirable growth, which retarded the ripening of the cane, and resulted in juices of low purity and low sugar content. On the other hand this self-same stimulating property has been of the greatest service to yellow and "nitrogen-hungry" cane, and with the application of small amounts of this material, wonderful tonic effects have been produced in an extremely short space of time.

In regard to the influence of nitrate on tasseling, Mr. Geo. Renton of Ewa Plantation writes: "My experience in one case with a late application in September of nitrate of soda was that it materially effected tasseling. About one-third only of the stalks flowered. As the application in this instance was made for the express purpose of preventing the tasseling of the cane, these results were gratifying." Mr. Renton further says: "It is my opinion that either excessive or late applications of nitrate of soda will lower the juice purity. The best juice obtained at this mill was from canes upon which nitrate was put on not later than the latter part of April." The experience of Mr. Olding at Kohala has been that "nitrates prevent tasseling in a very marked degree." It was observed last year at the Experiment Station that nitrogenous fertilizers in general prevented tasseling during the flowering period, whereas, unfertilized plats, and plats receiving merely potassic and phosphoric acid fertilizers flowered without exception. On account of the readily available condition of nitrate of soda we should expect small applications of this material to exert a more potent influence in preventing tasseling than would be the case with either sulphate of ammonia, or organic nitrogen.

Some difference of opinion exists as to the amount of nitrate that can be judiciously added to the soil, and reference will be made to that subject later on.

Attention has been called to the fact that where nitrate of soda and chloride of potash are applied to the same land, a chemical reaction might ensue to the detriment of the soil. This supposition is based on the fact that the solium of the nitrate of soda has a strong affinity for chlorine, which forms a part of the chloride of potash, and that the two elements might combine with each other to form common salt. Although this reaction is within the realm of probability we are without the necessary data for a confirmation of this view.

However it is better to be on the safe side, and on account of this probable interchange of elements to use potassium sulphate instead of potassium chloride, where nitrate of soda is being used on the land.

Sulphate of ammonia on account of its ready solubility, and small liability to waste as compared with nitrate of soda, is held in much favor as an economical nitrogenous compound. At 15° C. 1.3 parts of water dissolve one part of sulphate of ammonia and it is seen that little difference exists between its solubility and that of nitrate of soda, rendering its diffusion throughout the soil almost as complete as in the case with the latter substance. However it has one very strong advantage over the nitrate of soda, in its ready ability to become fixed in the soil, and on that account alone, its particular suitability for some locations is very apparent. If we refer to the results previously given as to the comparative waste of the two fertilizers under similar conditions, a striking contrast is noted. Of 200 grams of this material added to the land in the lysimeter tests only 3.52 grams of its nitrogen was lost in drainage waters, as compared with 72.56 grams of nitrogen lost from an equal amount of nitrate of soda. Of this small loss, 3.08 grams were in the form of nitrate, into which condition it had been converted by the nitrifying bacteria of the soil as previously mentioned. Only .44 gram of nitrogen escaped in the form of sulphate of ammonia.

To show Mr. Crawley's experience with this salt on "sandy soils," we will give his determinations in full, the conditions of his experiments having been described on page 13

	1.	2.	3.	4.
Amount of moisture in the original soils....	3.73 per ct	2.03 per ct	1.08 per ct	0.61 per ct
Carbonate of lime in the soil............	71.15 per ct	77.37 per ct	81.85 per ct	91.07 per ct
Weight of soil taken...	365 grs	407 grs	362 grs	374 grs
Time required te penetrate two feet......	55 min	19 min	12 min	8 min
Total water passing through............	320 cc	342 cc	345 cc	355 cc
Time required for the above water to pass through............	335 min	180 min	95 min	95 min
Water holding power of the soils..........	49 per ct	39 per ct	43 per ct	38 per ct
Moisture in soils after ten days......... ..	31 5 per ct	20.4 per ct	18.8 per ct	16.6 per ct
Sulphate of ammonia lost.	8 per ct	42 per ct	59 per ct	86 per ct
Muriate of potash lost	None	44 per ct	56 per ct	65 per ct
Sulphate of potash lost................	None	8 per ct	25 per ct	28 per ct

"Nitrate of soda practically all was lost, there being little difference in the various soils." It will be seen that where the lime carbonate of the soil amounts to 71.15% only 8% of the sulphate of ammonia was lost, but the loss increased rapidly in proportion as the content of lime carbonate became larger, a soil of 91.07% of lime carbonate only retaining 14% of the ammonium sulphate applied. These are unusual soils, however, and the proper conditions for holding the salt in question are notably lacking; but they afford us a proper realization of the superior power held by ammonium sulphate to become fixed under the most adverse circumstances. In the last column it is seen that one soil is composed almost entirely of coral or lime-stone, and that other ingredients must be present in very small quantities. As the double silicates in the land are most probably responsible for the fixing of the ammonia radical, it may be easily understood why the coefficient of fixation will be reduced in proportion as the bulk of the soil is taken up with carbonate of lime, and the silicates excluded.

As regards the action of ammonium sulphate as compared with nitrate of soda on the lime of the soil, there is a marked difference in favor of the former. In the lysimeter tests to determine this point, it was found that whereas 26.52 grams of lime were lost through the action of the nitrate of soda applied, only 5.49 grams were removed through the influence of the sulphate of ammonia. In making these comparisons, attention should be drawn to the amount of lime that was carried from the soil by the application of water alone without the addition of the various salts. This amount was 1.72 grams, and should be subtracted from the weights of lime removed, as given in the table on page 14, in order to reach the actual amounts of this soil element that were lost through the influence of the several agencies.

The action of ammonium sulphate in the soil in furnishing nitrogen to the cane, is considerably different from that of the nitrate. The latter substance is in a suitable condition to be absorbed by the plant roots immediately on going into solution in soil water, or in coming in contact with the plant root acids. The ammonia of the ammonium sulphate on the other hand has to be oxidized by soil bacteria and changed into nitric acid before it reaches an assimilable state for the cane. This difference in the immediate availability of the two compounds will explain to a large extent the several differences displayed in their effects upon the crop. The nitrogen as nitrate is so readily absorbed when applied to the land as to act like a stimulant, while the more slowly acting nitrogen of ammonium sulphate is yielded more gradually as a plant food, and forms a longer lasting supply of this material, per given weight of ammonium sulphate added than that from the nitrate of soda.

We now come to a consideration of nitrogen as supplied from organic sources. The chief nitrogenous substances of this order as applied to Hawaiian soils, are dried blood, tankage, and fish scrap or "fish-guano." Of these materials dried blood unquestionably ranks first, both in its high content of nitrogen and the ease with which it is rendered available by the micro-organisms of the soil. In a perfectly dry state it has been known to run as high as 14 per cent of nitrogen. The samples of this material received at the Experiment Station would indicate an average of about 12 per cent., with a small amount of water.

Tankage, though containing less nitrogen than the blood, is an organic source of nitrogen of no little value. It is composed of scraps and fragments of flesh which have been dried and ground, after the removal of fats by steaming. Tankages have been received at the Experiment Station for analysis which were found to have as high as 10 per cent phosphoric acid in addition to their liberal content of nitrogen, which gives them added value as fertilizing compounds.

Fish scrap, on the average, contains about 8 per cent of nitrogen and 7 per cent of phosphoric acid. It constitutes the ground residue of fish from which the fats and oils have been largely removed, and varies considerably in its value as a manurial substance. Occasionally samples are met with which contain a large amount of fatty matter, and these fats and oils when present in considerable quantity cause the other organic matter to decompose with great difficulty in the soil. Some years ago a sample was received at the Experiment Station laboratory which was found on analysis to contain over 24 per cent of total fats.

In the consideration of organic substances as a source of nitrogen, a distinct difference is manifested between them and the soluble chemical salts which have just been discussed. Nitrate of soda and sulphate of ammonia, on account of their solubility in water, may be readily taken up by that medium and distributed throughout the mass of the soil. The organic material on the other hand can only be applied to the land in spots and needs slight covering to depths varying with the nature of the soil and of the substance used, in order that the most suitable conditions will be reached for thorough decomposition and nitrification.

(CONTINUED IN NEXT ISSUE)

ERRATA.

In the December number of this periodical the following errata occurred:

Page 553, in 12th line from bottom, for 24x28, read "24x48."

Page 554—10th line from top, read "gate" for "grate."

Page 555—15th line from bottom, for "juice" read "lime."

Page 566—3d line from top, for "frame" read "flame."

Page 572—2d line from top, between the words "pump" and "for," should be added "by the Geo. F. Blake Manufacturing Co., N. Y. Vacuum pump."

Page 575—9th line from bottom, for "2 ft." read "22 feet."

Page 581—18th line from bottom, for "94.20" read "84.20."

Page 582—6th line from top, for "foot" read "inch."

Page 586—18th line from top, for "80°" read "98°."

Page 588—15th line from top after the first paragraph, insert the following: "The sugar, after being dried in the granulator will not pack as closely in the bag as when filled direct from the centrifugals, and we sometimes find some little difficulty in getting them to hold 115 lbs., while in the ordinary drying, they easily hold 125 pounds."

Page 590—9th line from top of first paragraph, for "finest" read "first."

HONOLULU STOCK AND BOND EXCHANGE, FEB. 14, 1902.

STOCK	Capital Authorized	Shares Issued	Capital Paid up	Par Value	Last Sale
MERCANTILE					
C. Brewer & Co............	$ 1,000,000	10,000	$ 1,000,000	$ 100	415
N. S. Sachs' Dry G'ds Co. L'd.	60,000	600	....	100	100
L. B. Kerr & Co., Ltd.......	200,000	4,000	....	50	
SUGAR					
Ewa Plantation Company ...	5,000,000	250,000	5,000,000	20	22½
Hawaiian Agricultural Co...	1,000,000	10,000	1,000,000	100	270
Hawaiian Com'l & Sugar Co.	10,000,000	100,000	2,312,750	100	80
Hawaiian Sugar Company...	2,000,000	100,000	2,000,000	20	27
Honomu Sugar Company...	750,000	7,500	750,000	100	130
Honokaa Sugar Company ...	2,000,000	100,000	2,000,000	20	33¼
Haiku Sugar Company......	500,000	5,000	500,000	100	.....
Kahuku Plantation Company	500,000	25,000	500,000	20	24
Kihei Plant. Co. Ltd, ...	2,500,000	50,000	2,500,000	50	11½
Kipahulu Sugar Company...	160,000	1,600	160,000	100	....
Koloa Sugar Company......	500,000	5,000	500,000	100	164
McBryde Sug. Co. Ltd.......	3,500,000	175,000	3,500,000	20	15
Oahu Sugar Co............	3,600,000	36,000	3,600,000	100	90
Onomea Sugar Co	1,000,000	50,000	1,000,000	20	23
Ookala Sugar Plantation Co.	500,000	25,000	500,000	20	9
Olaa Sugar Co. Ltd., Assess.	2,500,000	125,000	865,000	20	5
Olaa Sugar Co. Ltd., Paid up	2,500,000	125,000	2,500,000	20	14
Olowalu Company	150,000	1,500	150,000	100	.....
Paauhau Sug. Plantation Co.	5,000,000	100,000	5,000,000	50	.....
Pacific Sugar Mill	500,000	5,000	500,000	100	.....
Paia Plantation Company ...	750,000	7,500	750,000	100	250
Pepeekeo Sugar Company...	750,000	7,500	750,000	100	.....
Pioneer Mill Company......	2,250,000	22,500	2,250,000	100	100
Pioneer Mill Company Ass..	500,000	5,000	125,000	100	25
Waialua Agricultural Co....	4,500,000	45,000	4,500,000	100	55
Wailuku Sugar Company....	700,000	7,000	700,000	100	370
Waimanalo Sugar Company	250,000	250,000	250,000	100	160
Waimea Mill Company......	125,000	125,000	125,000	100	87
MISCELLANEOUS					
Wilder Steamship Company	500,000	5,000	500,000	100	100
Inter-Island Steam Nav. Co.	600,000	6,000	600,000	100	100
Hawaiian Electric Company.	500,000	5,000	500,000	100	110
Honolulu R. T. & Land Co...	250,000	2,500	250,000	100	95
Mutual Telephone Company	150,000	13,900	139,000	10	8
Oahu Railway & Land Co ...	4,000,000	40,000	4,000,000	100	85
BANKS					
First National Bank	500,000	5,000	500,000	100	.....
First Am. Sav. B. & Trust Co.	250,000	2,500	250,000	100	.....
BONDS	Amt. of Issue				
Hawaiian Govt. 5 per cent...	1,251,200	Dec. 31, 1900	....	.....	97
Hilo Railroad Co., 6 per cent	1,000,000	750,000	....	.....	100
Hono. R. T. & L. Co , 6 p. c.	300,000	....	....	.....	.....
Ewa Plantation 6 per cent...	500,000	....	....	.....	100
Oahu Railway & L'd Co 6 p. c.	2,000,000	....	....	.....	104½
Oahu Plantation 6 per cent..	750,000	....	....	.....	100
Olaa Plantation 6 per cent ..	1,250,000	....	....	.....	.....
Waialua Agr. 6 per cent.....	1,000,000	....	....	.....	101

PLANTATION DIRECTORY.

Island and Name.		Manager.	Post Office
OAHU.			
EwaPlantation Co	*	G. F. Renton	Honouliuli
Waianae Sugar Co. Ltd	***	Fred Meyer	Waianai
Waialua Agricultural Co	*	W. W. Goodale	Waialua
Kahuku Plantation Co	xx	Andrew Adams	Kahuku
Waimanalo Sugar Co	**	G. C. Chalmers	Waimanalo
Oahu Plantation Co	x	Aug. Ahrens	Waipahu
Honolulu Sugar Co	**	J. A. Low	Aiea
Heeia Agricultural Co. Ltd	*x*	W. W. McGowan	Heeia
Laie Plantation	x*x	S. E. Wooley	Laie
MAUI.			
Olowalu Sugas Co	**	E. Kruse	Lahaina
Pioneer Mill Co	x	L. Barckausen	Lahaina
Wailuku Sugar Co	**x	C. B. Wells	Wailuku
Hawaiian Commercial & Sugar Co	x*	H. P. Baldwin	Spreckelsville
Paia Plantation	x*	D. C. Lindsay	Paia
Haiku Sugar Co	x*	H. A. Baldwin	Hamakuapoko
Hana Plantation	xx	K. S. Gjerdrum	Hana
Hamoa Plantation	**x	J. R. Myers	Hamoa
Kipahulu Sugar Co	x	A. Gross	Kipahulu
Kihei Plantation	x*	James Scott	Kihei
Maui Sugar Co	‡	W. S. Akana	Huelo
HAWAII.			
Paauhau Plantation	**	Jas. Gibb	Honokaa
Hamakua Mill Co	**x	A. Lidgate	Paauilo
Kukaiau Plantation	x	J. M. Horner	Paauilo
Kukaiau Mill Co	*x	E. Madden	Paaulio
Ookala Sugar Co	**x	W. G. Walker	Ookala
Laupahoehoe Sugar Co	*x	C. McLennan	Papaaloa
Hakalau Plantation	**	Geo. Ross	Hakalau
Honomu Sugar Co	**x	Wm. Pullar	Honomu
Pepeekeo Sugar Co	*x	H. Deacon	Pepeekeo
Onomea Sugar Co	**x	J. T. Moir	Papaikou
Hilo Sugar Co	**	J. A. Scott	Hilo
Hawaii Mill Co	x	W. von Graevemeyer	Hilo
Waiakea Mill Co	*x	C. C. Kennedy	Hilo
Hawaiian Agricultural Co	**x	C. M. Walton	Pahala
Hutchinson Sugar Plantation Co	**	G. C. Hewitt	Naalehu
Union Mill Co	*x	Jas. Renton	Kohala
Kohala Sugar Co	*	E. E. Olding	Kohala
Pacific Sugar Mill	x**	D. Forbes	Kukuihaele
Honokaa Sugar Co	x**	Jno. Watt	Honokaa
Kona Sugar Co	xxx	J. Cowan	Holualoa
Olaa Sugar Co	xx*	F. B. McStocker	Olaa
Puna Sugar Co	xx*	W. H. Campbell	Kapoho
Halawa Plantation	x*x	T. S Kay	Kohala
C. F. Hart, (Niulii)	*x	R. Hall	Kohala
Hawi Mill & Plantation	‡‡	John Hind	Kohala
KAUAI.			
Kilauea Sugar Co	**	G. R. Ewart	Kilauea
Gay & Robinson	x*x	Gay & Robinson	Makaweli
Makee Sugar Co	**x	G. H. Fairchild	Kealia
Grove Farm Plantation	x	G. N. Wilcox	Lihue
Lihue Plantation Co	x	F. Weber	Lihue
Koloa Sugar Co	x	P. McLain	Koloa
McBryde Sugar Co	*x	W. Stodart	Eleele
Hawaiian Sugar Co	x*	W. A. Baldwin	Makaweli
Waimea Sugar Mill Co	*	J. Fassoth	Waimea
Kekaha Sugar Co	x	H. B. Faye	Kekaha

Key	Honolulu Agents	
*	Castle & Cooke	(4)
**	W. G. Irwin & Co	(8)
***	J. M. Dowsett	(1)
x	H. Hackfeld & Co	(9)
xx	M. S. Grinbaum & Co	(2)
xxx	McChesney & Sons	(1)
*x	T. H. Davies & Co	(8)
**x	C Brewer & Co	(7)
x*	Alexander & Baldwin	(5)
x**	F. A. Schæfer & Co.	(2)
xx*	B. F. Dillingham & Co	(2)
x*x	H. Waterhouse & Co	(3)
x	C. Bolte	(1)
‡	Wong Kwai	(1)
‡‡	Hind, Rolph & Co	(1)